THE

ELECTRICAL REVIEW.

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THE

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SMOKE AND ITS DIMINUTION.

Mr. BRYAN DONKIN writes on this subject in the *Engineer*, dealing chiefly with the various methods adopted for measuring smoke. We need not recapitulate these. They are various, and include from photographs of chimney tops when smoking, classified according to a more or less arbitrary manner, as means of comparison, to the filtration of the black particles from a given volume of rejected gases. Other systems are equally cumbersome and inapplicable in general work. The number of scales or degrees proposed to classify smoke has been from as low as three up to as high as 10. Both these numbers are considered by Mr. Donkin to be extremes. Five shades as employed in Switzerland appear to him a good number, and he has used them all.

The Swiss shades may be described as (1) white transparent vapour; (2) light brown; (3) brownish grey; (4) dense smoke; (5) thick black smoke. Germany, also, has largely adopted a scale of five, but equally empirical, and each observer is thrown on his own idea of what each word description really means.

The author refers to the Ringelmann smoke scale as the best yet presented. We have ourselves used the Ringelmann scales with pleasure, and have previously referred to them in these columns. Some further description will not, however, be out of place.

Ringelmann represents different shades of colour by means of two series of black lines drawn regularly at right angles on a sheet of white paper. He varies the breadth of the lines so as to shut out more or less of the white surface. Seen at a distance of about 80 feet or 100 feet, though we have found 50 feet a very convenient distance, there is nothing visible of the chess-board appearance; the white rectangles and black lines merge into a uniform tint of grey.

In using the Ringelmann shades we hung the paper where we could see both it and the chimney to be tested, and it was not difficult to determine which shade represented most nearly the particular smoke shade from time to time. Anyone can draw these diagrams for himself to any size he may desire. It is of course essential that they should be accurate when they will form a standard of comparison, and as such, in France, America, and in this country, they have already been printed. There are six shades, No. (0) all white, to No. (5) all black for very black smoke.

The intermediate shades of (1) light grey, (2) darker grey, (3) very dark grey, (4) black, are drawn as follows:—

1. Black lines 1 mm. thick; white spaces 9 mm., the black lines crossing at right angles.
2. Black lines 2·3 mm. thick; white rectangles 7·7 mm.
3. Black lines 3·7 mm.; white rectangles 6·3 mm.
4. Black lines 5·5 mm; white rectangles 4·5 mm.

Thus all the black lines are drawn at 10 mm. apart, centre to centre. They may be drawn to double scale and photographed down, the ratio of black to white will be the same,

but the distance for them to be placed from the observer will vary. The true distance is that at which all the lines merge into an even shade of grey all over the surface. Mr. Donkin advises two observers, one to note colour, the other to plot same every minute on a chart, upon which the particulars of stoking should be noted. We agree with Mr. Donkin that Ringelmann's scales are the best. They are much used in France.

THE COAL SUPPLY OF KENT.

Some nine bore holes are in progress in Kent with a view to the finding of coal. Since the deep borings at Tottenham Court Road, Turnford, Harwich, and other places, demonstrated the existence below the comparatively recent strata of the London Basin of old rocks at a comparatively small depth, and the later boring at Culford showed pre-carboniferous rock at a depth of little over 200 yards, there has set in a strong disposition to prove the opinion of Godwin Austin, expressed 43 years ago, that beneath Kent there probably existed hidden folds of coal-bearing rock forming a portion of the coal field of which the fields of Somersetshire and the Ardennes are but extensions. Already proved near Calais, Dover seemed particularly suitable as a place to be tested, and shafts are now being sunk to win the seams there found. It is to be hoped that success will attend these efforts at a depth of 2,000 feet; a 2-foot or even a 4-foot seam of coal is costly to get, and much depends on cheap carriage to market if the coal is to be sold at a profit. Excepting the pits which may have access to the sea, the prospect of sufficiently low freight rates by the existing lines in Kent is not very reassuring. Coal brought to London by the Northern lines is charged fully twice as much—indeed, four times as much—as ought to pay handsomely for carriage, and, so far as this goes, the Kent coal, if obtained, will only have to compete with fuel of unnecessarily high price, and could the Kent coal be carried to market for a reasonable sum, it ought to be possible to mine it at a profit. Coal can be delivered in the neighbourhood of pits in the North and Midlands for, say, 5s. per ton. There is a huge margin for carriage between a selling price of 5s. per ton and the London price of 15s. and 20s.

For some reason not very easy to fathom, the southern railroads of England appear all to have fallen into thoroughly incompetent management. They appear unable to conduct either passenger or goods traffic on lines which suggest themselves to common-sense men. With coal within 50 miles of London, in a district where, even if well managed, the railways are insufficient to properly serve the district, there should be some prospect of constructing an entirely new and direct main line to London, with branches to the new coalfields, and working by electricity. The current could be cheaply generated at the mines and transmitted upon the high tension system. Being a railroad, and fenced in, a third-rail system only would be necessary. Being originally devised for electric traction, there would be no old plant to throw away, so dear to the heart of the average railway director.

It may be that while some of the coal found will be of excellent quality, much of it may be quite inferior. Here, again, starting *ab initio*, what may be a poor steam coal may be eminently suitable for gas production. The employment of large and comparatively tall gas producers of the blast furnace type with electricity generated by gas-driven machinery presents itself at once as embodying all the features of latest modern practice, while at the same time power is being produced from coal without smoke. Such a utilisation of coal—and the Kent coal will be of bituminous variety—in an agricultural district where manures are so essential to the crops and smoke is undesirable, presents itself as a means of producing power smokelessly, and, if it is desirable, of manufacturing sulphate of ammonia, as in the residuals plant of coal-using blast furnaces. The objection on æsthetic grounds to the finding of coal in Kent and Sussex would still exist. It would be impossible to carry on such an industry without some harmful results. But it ought to be possible, and it is possible, to conduct the operation of coal getting and power production so innocuously as not to be noticeable except by actually seeing the works. The visible effect on vegetation ought to be *nil*. Disfigurement should cease at the boundary wall of the pit head and power house. All this is possible, and economical.

Electricity in a Ceylon Tea Factory.—From the Ceylon papers we understand that electrical power transmission has been adopted by Messrs. Whittall & Co., who have laid down a plant at Hayes Estate, in the Morowaka korale, the property of the Union Estate Company. A waterfall situate a third of a mile from the estate, with a fall of 250 feet, develops in a Pelton wheel 18½ brake H.P., and this drives various machinery, including a Brown's roller, a 32-inch Rapid roller, an Economic roller, a Downdraft Sirocco, a No. 3 Dessicator, a Venetian dryer, a Roller breaker, and a made-tea sifter. Overhead conductors (bare) convey the current to the motors in the tea factory, rubber insulated cables being used within the building. The plant is entirely in the hands of coolies, and it was erected under the supervision of Mr. Garratt, engineer to Messrs. Whittall. The scarcity of fuel and the difficulties of transport in such parts of the world should lead to considerable developments of this nature, where the water power available is sufficiently large for the purpose.

Standards for Direct Connected Sets.—At the May meeting of the American Society of Mechanical Engineers a paper by Mr. Stanwood was read, in which attention was drawn to the necessity for some change in practice as regards generator sets. It was observed that electric generators, being built without reference to the engine to drive them, had played havoc with standardised engine construction. Representatives present from both the engine and dynamo building industry took part in the discussion, and agreed there was really no difficulty in deciding upon a set of standards which would accomplish all the author aimed at, and it was unanimously agreed that the society should communicate with the American Institute of Electrical Engineers with a view to the appointment of a joint committee to determine and recommend a set of standards of capacities, speeds, and dimensions of those parts affected by the combination of engines and dynamos in one set. Thus, again, we find practice is being standardised. It is sometimes thought that standardising leads to the stoppage of progress. This is not necessarily the case. Its tendency properly controlled is to check hasty changes, but with proper discussion it tends also to make known novel points and improvements, and standards can be developed on sound lines. But standardisation is perhaps chiefly beneficial in putting a stop to the waste and inconvenience of a too great multiplicity of types. In engineering there is no objection to distinct species—we do not desire too many variants on these species.

THE EXPERIMENTS OF PROF. HUGHES ON ETHER TELEGRAPHY.

By J. MUNRO.

Prof. Hughes was kind enough to show me his original experiments on ether telegraphy whilst he was at work on them, but although I suggested their publication he declined to sanction it. Now that Mr. Fahie has drawn the secret in a letter from him, I am able, by his courtesy, to write the following account of them :—

In 1877, as we already know, Prof. Hughes, confined to his rooms with a cold, began the experiments which led to the invention of the microphone. He seems to owe that chill the better part of his renown ; for it introduced him to a series of discoveries which hung together. In working with the microphone he was troubled by induction, and devised not only a method of annulling it on telephone lines, but the induction balance and sonometer. A still more valuable prize was lurking in this corner of research, like a nugget of gold in the sand of the prospector, and had he been careless or unskilled he might have missed it, as many miss their luck, for want of eyes to see.

When at work on his induction balance, a battery and interrupter in the primary, and a telephone in the secondary circuit, he was troubled sometimes with a noise in the telephone, and could not get a balance. The source of the evil was a loose joint in the wire of the secondary circuit, and on substituting a microphone for it he found a similar disturbance in the telephone. Apparently the effect was not caused by the induction of the primary on the secondary coils, which he could suppress by adjustment, but was directly due to the "extra spark" produced at the interrupter in making and breaking the current.

The phenomenon was new to him, and he began to investigate it, with his usual self-made apparatus of the simplest kind—sewing needles, bits of cork, wood, and carbon, odds and ends of wire, pomade bottles, penny boxes, purchased at a dentist's, and presumably for holding false teeth, not forgetting, of course, the indispensable red sealing-wax to stick the parts together. I am afraid that a dealer in old curiosities would scarcely give the entire collection house room.

The infinite pains Prof. Hughes must have taken are well shown by what remains of these instruments and the square black note books filled with numerous experiments in ink or pencil, dated or dateless, some of them marked "extraordinary" or "important." The most interesting or fruitful of them run from October to the end of 1879, but he did not quite abandon the subject until 1886.

At the outset he joined a single cell, B (fig. 1), in circuit

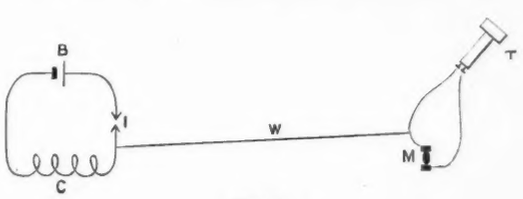


Fig. 1.

with a clockwork interrupter, I, and a primary coil, C, from the induction balance. This "transmitter" was connected by a wire, W, several feet in length to the "receiver," a telephone, T, in circuit with a microphone, M, and the "extra spark" of the interrupter was distinctly heard in the telephone.

The battery, B (fig. 2), a simple acid cell in a pomade bottle, and the small mahogany bobbin, C, about 2 inches in diameter, wound with copper wire, covered with green silk, produced no visible spark when the current was broken, but strange to say it seemed to charge the whole atmosphere and walls of the room for the moment. With a battery of six cells the effect was so strong as to damage the insulation of the coil.

The noise in the telephone was influenced by the nature of the extra spark. With an electromotive force of $\frac{1}{50}$ volt it was better than with several cells. It was louder and clearer when the contacts of the interrupter were of metal to metal, not metal to carbon or carbon to carbon. Again, an iron core in the coil, though it gave a stronger spark, did not improve the sound, but on the contrary. Indeed, the spark

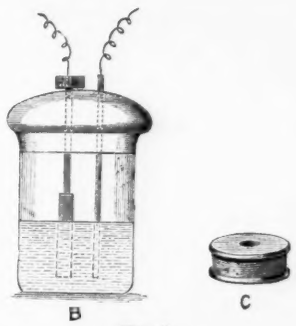


Fig. 2.

from the Faraday electro-magnet of the Royal Institution excited by a large Grove battery, had little effect on the microphone and telephone. Even a dynamo at work beside the receiver gave a very poor result.

The tiny spark from a stick of sealing wax rubbed on the sleeve was more effective than the discharge from a big Leyden jar, but a spark was requisite, for the jar, heavily charged and simply held near the microphone, did not seem to influence the telephone.

The Professor concluded that a small, thin, quick spark was better for the purpose than a large, thick, slow, or "fat" spark, to use his own term. A short, sudden, rather than a long, gradual change of potential is desirable, and hence it does not follow that increasing the size of the sparks will improve the efficiency of the "wireless telegraph." Moreover, the sinuous currents necessary to transmit speech are unsuited for the microphone "coherer," and a "wireless telephone" cannot be expected unless a different method is found out.

Prof. Hughes tried many experiments to satisfy himself that his receiver, in other words, his microphone and telephone, was influenced by the extra spark and not by the ordinary electro-dynamic induction. He inserted coils in the transmitting and receiving circuits, placing them parallel and at right angles to each other, that is to say, in positions favourable and unfavourable to induction, but without modifying the effect. He also reduced the number of turns on the coil, C (fig. 1), and even eliminated it altogether, but when the battery and interrupter were only connected by 3 inches of wire, and the microphone to the telephone by as little, he still heard the sounds of the "make" and "break." That electrostatic induction did not count, was tried by inserting charged conductors of surface, for example, metal discs in the circuits, and shifting their positions with respect to each other. Apparently the influence might be described as conduction rather than induction. In short, it was evident that the extra spark of the interrupter was able to charge the whole surrounding space. It appeared to radiate electrical impulses or waves in all directions as a burning spark radiates light or heat, and these electrical rays impinging on the microphone produced a momentary current in it which caused a sound in the telephone.

Some imagined that heat produced the ordinary action of the microphone, and Prof. Hughes in seeking to explain the new effect supposed that the electric waves excited a thermo-electric current in it, and the fact that heating the contacts or making them of different materials enhanced the effect, is, perhaps, favourable to the view. If I may speak for myself, however, I regard the true cause of the action as a mystery at present. We may not understand it until we know what electricity is, but on the other hand, it may help us to that knowledge. Seemingly, the action of the receiving telephones of the Elisha Gray and Edison, in which a finger rubs on a metal plate, and a style on a chalk cylinder are also due to it. On suggesting to Prof. Hughes, however, that

electric waves might influence the chalk receiver as they do a microphone, and cause it to act, he thought the effect, if any, would be feeble.

Of course it was highly important to find the most sensitive form of microphone to receive the rays, as we may call them. Contacts of metal are apt to "cohere," or stick together, apparently by the electrical waves welding them. A microphone which is both sensitive and self-restoring, that is to say, does not cohere, is made with a carbon contact resting lightly on bright steel. Such a receiver is shown in fig. 3

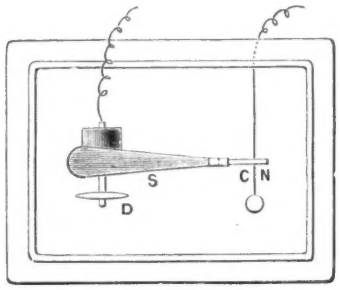


Fig. 3.

where C is a carbon pencil touching a needle, N, and S an adjustable spring of brass by which the pressure of the contact can be regulated with the disc, D. An extremely sensitive, but easily deranged form of microphone is represented in fig. 4, where S is a steel hook, and C is a fine copper wire

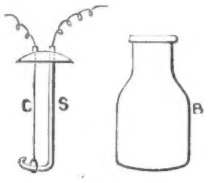


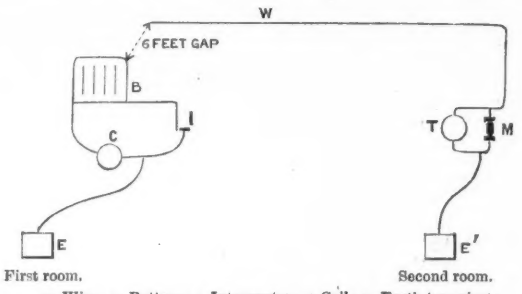
Fig. 4.

with a loop on the end which has been oxidised and smoked in a flame. The carbonised loop and steel contact are inserted into a small bottle, B, for safety. Another form of microphone which the Professor tried was a tube containing metal filings, which forestalls the Branly coherer of 1894, but as the cohering of the contacts is a disadvantage, he abandoned it, and regards the name "coherer" as a mistake. Contacts of iron and mercury are sensitive, but very troublesome. Iron and steel cohere, but are sensitive, and keep well when immersed in a mixture of petroleum and vaseline, which, though an insulator, does not bar the electric waves from them.

Some of these microphones, or coherers, were found, by experiment, extremely sensitive to small charges of electricity —far more sensitive than the gold leaf electroscope and quadrant electrometer. Even a metal filing on a stick of sealing wax carried enough electricity from a Leyden jar to affect the microphone it touched and give a sound in the telephone, but it had no effect on the electroscope or electrometer.

With such delicate receivers Prof. Hughes discarded the connecting wire, W, in fig. 1, and separated the receiver altogether from the transmitter—that is to say, he produced the germ of a "wireless telegraph." His first experiment of the kind was made between October 15th and 24th, 1879, the transmitter being in one room and the receiver in the next, but a wire from the receiver limited the air gap to about 6 feet. The transmitter and receiver were both connected to "earth" by the gas pipes. Fig. 5, which is roughly drawn from the Professor's own diagram, shows the arrangement. In another experiment, made about the middle of November, he connected a fender to the interrupter, as an exposed conductor of the radiations, or, to use a single word, a radiator. Instead of the fender he afterwards employed wires for the radiators and stiffened them with laths to hold them up.

The use of an "earth" led him to make the receiving circuit through the earth, with the telephone, T, joined to a gas pipe of lead, and the microphone, M, to a water pipe of iron, as in fig. 6. The effect was very good, and he traced it to the different metals of the pipes forming a weak "earth battery," by which a permanent current ran through the



W, Wire; B, Battery; I, Interrupter; C, Coil; E, Earth (gas pipe); T, Telephone; M, Microphone; E', Earth.

Fig. 5

circuit. In this case the electric waves influencing the microphone altered the strength of the permanent current. Acting on the hint, he included a battery in the circuit of the receiver. A single cell was more than enough, and even an electromotive force of $\frac{1}{50}$th volt was sufficient.

Prof. Hughes had now got all the principal elements of the "wireless telegraph" as we know it, and since he was groping in the dark before the light of Hertz arose, it seems little short of magical that in a few months, I might almost say weeks, and in using the simplest means, he forestalled the great advance of nearly 20 years.

Not only did he send and receive signals through space in this way all over his house, and from the third storey to the basement of Mr. Stroh's factory in the neighbourhood, where he employed the receiver, fig. 4, heated by a spirit lamp, but he would leave his transmitter working at home and walk up Great Portland Street with his receiver, holding the microphone

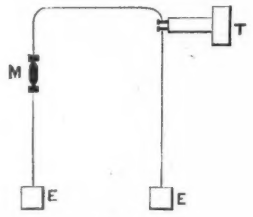


Fig 6.

in one hand and the telephone to his ear. The clicking of the transmitter could be heard for a distance of 500 yards up or down the street, and it seemed to die away at certain houses, probably because of nodes caused by interference of the electric waves, as proved by Hertz in 1887. Curious to tell, he also found that he could not hear so well when he turned so that his body was interposed between the transmitter and receiver, as though he stood in his own light; but he could hear well when another person—the late Mr. Despointes, superintendent of the Continental Gallery of the Post Office—was planted before him in the path of the rays. A trial made at the public baths, Tottenham Court Road, was unsuccessful, as the noise of the water made it impossible to hear the telephone.

In February, 1880, Prof. Hughes, intending to read a paper to the Royal Society, showed his experiments in confidence to the president, Mr. Spottiswoode, along with the secretaries, Profs. Huxley and Stokes. At first they were surprised, but Prof. Stokes afterwards declared that "induction" could explain them, although he considered there was sufficient to make a paper for the Society. Prof. Hughes, believing that he had discovered a novelty, refused to contribute the paper. Disheartened by the adverse criticism of a high authority, he drifted into researches on magnetism, and was content to sit and see others re-discover what he already knew, without making a single claim to priority. His golden silence has doubtless cost the world some 10 or

20 years of wireless telegraphy, and I presume that if the time were to go over again he would speak, but after all it may serve to redeem the age from a charge of self-advertisement, and we need not despair of modesty in merit, as long as we can show a man of action like General Gordon, and a man of science like Prof. Hughes.

THE SCHATTNER STANDARD METER.

In our issue of November 25th, 1898, we described an electrical prepayment meter, the Long-Schattner meter, which offers peculiar advantages in the simplicity of its construction. Messrs. Schattner & Co., of Timberhill, Norwich, who manufacture this meter, have found it so satisfactory in practical working that they have lately brought out an integrating meter for ordinary domestic supply designed on the same principle. The action of these Schattner instruments depends on measuring the amount of electricity that has been supplied to a house by the loss in weight of a copper anode suspended in an electrolytic cell of sulphate of copper from the beam of a balance. The cell itself is also of copper, and the current or a known fraction of it dissolves copper from the suspended anode and deposits it on the containing cell, maintaining the solution constant. The idea of measuring a supply of electricity by the electrolysis of copper sulphate is of course very old—it is the basis of Edison's first meter—but this Schattner meter is interesting from the ingenious use made of the balance arm. In the prepayment meter the anode and the pan to receive coins hang from one arm of the beam and are balanced by a fixed counterpoise on the other arm. When the fixed weight preponderates the beam tilts, lifts a connection piece out of a pair of mercury cups, and breaks the house circuit. When the combined weights of the anode and the coins preponderate, the beam tilts the other way and closes the house circuit through the mercury cups. The insertion of a coin in the coin pan closes the house circuit, which remains closed until the reduction of the weight of the anode by the current compensates for the addition of the coin and breaks the circuit again. Those of our readers who did not see the illustrated description of this meter will nevertheless recognise how directly this solution meets the conditions of a prepayment meter. The coin by its very weight provides not only an exact measure of the current purchaseable by it, but also a convenient means of actuating the switch.

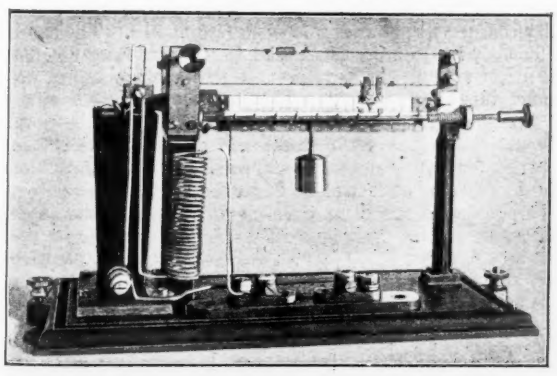


Fig. 1.

Fig. 1 shows the extension of this design to an ordinary integrating meter. The coin pan and mercury switch are removed and for the fixed counterpoise of the prepayment meter, a steelyard is substituted very similiar to the steelyard of an ordinary weigh bridge. The adjustments of the large and small weights are made by milled heads which project through the cover of the case, so that the weight of the anode can be ascertained at any time by turning the milled heads till the balance is brought to the zero mark. The machine is now, in fact, nothing more than a cathode hung in a copper sulphate cell from a simple weighing machine manipulated from outside the case. Only a fraction of the total current passes through the cell, the remainder being carried by a shunt. The fall of potential in the meter is said to be only ·7 volt at full load for a 100-volt circuit, and one cathode and cell will meter upwards of 1,000 units. The working connections are clearly shown in the diagram of fig. 2. B is the anode suspended from the short arm A of

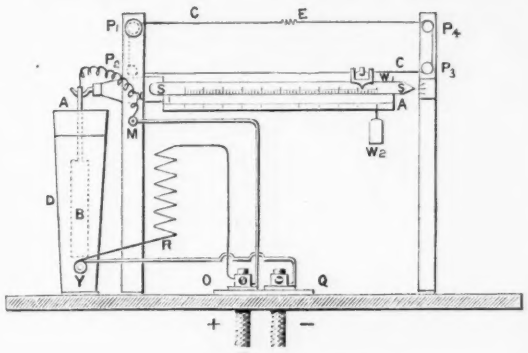


Fig. 2.

the balance in an electrolytic cell D. R is the shunt connected in parallel with the cell. S S is the steelyard. W_2, the heavy weight, hangs in any one of a series of notches, and the movement of the small weight, W_1, along the whole length of the graduated scale is equivalent to the movement of W_2 by the distance of one notch. W_1 is moved by an endless cord C C, by a handle at P_1, and W_2 by a rod omitted from fig. 2, but shown clearly in fig. 1.

Now, with every increase of the distribution pressure of town mains, the accurate meterage of small currents becomes of greater importance, and a simple meter which can be trusted to pick up the current supplied, say, to an 8-candle lamp working at 250 volts, and 2·5 watts per candle, should have a large demand. No meter has yet been proposed to do this comparable in simplicity with an electrolytic cell.

RECENT PROGRESS IN THE APPLICATION OF THE RÖNTGEN RAYS IN SURGERY.

When Röntgen's great discovery put into our hands the means of detecting the presence of metallic or other foreign substances imbedded in the tissues of the human body, everybody anticipated that great benefits would result from the application of the new discovery to surgery. Among surgeons themselves, however, the opinions were more divided; some even declared that nothing could be done with the help of the Röntgen rays that could not be done by the older methods.

Whatever may be the case in other branches of surgery, there can be no doubt that the Röntgen rays have made possible operations in ophthalmic surgery which hitherto were impossible; and this result is due chiefly to the beautiful instruments for localising the foreign bodies which have been elaborated by Mr. Mackenzie Davidson. The development and application of these instruments were explained by Mr. Mackenzie Davidson on 15th ult. in an interesting address to the Camera Club.

The object aimed at in Mackenzie Davidson's localisation apparatus is to find the x, y, z, or co-ordinates, of the foreign body, relatively to three fixed planes; and this he does by an apparatus in which the rays, passing through the focus of the lamp, the foreign body and its image on a photographic plate are represented by threads. When two images are produced by placing the focus of the lamp in two different positions, the intersection of the two threads representing the rays in the two positions determines the position of the foreign body. Apparatus designed by Mr. Davidson on this principle has already been described in the Electrical Review; but apparatus sufficiently good to localise a bullet in the trunk or the limbs was found insufficient to indicate with the necessary exactness the position of small particles in the eyeball.

In the first place the ordinary commercial focus tube was found to be not quite good enough, inasmuch as the focus on the anti-cathode from which the rays proceeded was usually an area of some size, and not a point as required by the mathematical theory of the localising instruments. Mr. Davidson found, by means of a tube with an adjustable anti-cathode, that at a certain distance from the cathode the focus was sufficiently sharp for all practical purposes. Tubes with the anti-cathode on either side of the correct focal point he calls "astigmatic," and he has devised ingenious apparatus for detecting the presence of "astigmatism" in focus tubes.

If a piece of wire gauze is held close to the tube so that its plane intersects the plane of the anti-cathode at right angles, and the image of this gauze is examined with a fluorescent screen; then if the tube is free from astigmatism, the horizontal and vertical wires of the gauze will appear equally sharp. But if the tube is astigmatic, only the wires parallel to the plane of the anti-cathode will be sharp, those at right angles appearing fuzzy. Another instrument used for testing tubes for astigmatism is a multiple pinhole camera. A number of pinholes is made at equal intervals in a strip of tinplate, which is bent into semi-cylindrical form. The anti-cathode of the tube is placed at the centre, with its plane coinciding with the axis of the semi-cylinder. The form of the images on a photographic film, bent into a semi-cylinder, and placed a few inches away from the pinholes, will determine whether the tube is astigmatic or not. If the tubes are non-astigmatic, all the images will be sharp, and of the same shape and size, otherwise those in the centre will be different from those at the sides.

When tubes with a sharp focus were obtained a new difficulty arose. The platinum anti-cathode was fused and perforated by the intense heat developed at the focus. This led Mr. Davidson to make use of osmium instead of platinum. The osmium was found to be sufficiently infusible itself, but the holder was usually fused, and allowed the osmium to drop. The last tube constructed by Mr. Cossor for the lecturer was shown under the action of a coil with a Wehnelt break. The osmium was heated to a brilliant white heat, and gave good screen images through the bodies of several of the members of the Camera Club. The osmium in this tube was clamped between two perforated platinum plates which were riveted together, the osmium projecting through the central perforations.

In the localising apparatus used for the eye, a small wire is fixed under the eye with its point just under the eyeball. The co-ordinates of this point are determined at the same time that those of the foreign body in the eye are determined. The differences of the two sets of co-ordinates show the position of the particle in the eye relatively to the point of the wire, and from the point of the wire these distances are set off for the use of the surgeon.

The two images produced by displacing the focus tube in Mr. Davidson's localising apparatus are evidently stereoscopically related to each other, and when taken on separate plates and viewed in a stereoscopic, the eye itself determines the true position of the foreign body. The use of these stereoscopic pictures have been found to be an invaluable aid to the surgeon, in conjunction with the measurements given by the localising apparatus.

Since over 100 cases have been successfully operated upon by the help of Mr. Mackenzie Davidson's apparatus, it is evident that the introduction of this apparatus marks a real practical advance in ophthalmic surgery.

THE OPERATION OF AN INTERURBAN ELECTRIC RAILWAY.

THE city of Cleveland, Ohio, is a particular centre of activity for electric lines. One line extends to Lorain, 18½ miles distant, and being built on its own right of way and free of grades and curves, a speed of 45 to 50 miles is often made, for the schedule time is 45 minutes, and there are numerous stops.

The cars weigh 22½ tons and have each four G.E. motors of 50 H.P. each. In winter the service is hourly, in summer a half-hour service is run.

On the hourly service only two or three cars are at any one time upon the 18½ miles between Lorain and Rocky River, which is the section fed by current from the railway power house. In summer there are often four or five cars as well as additional excursion cars. There are thus liable to be very great load fluctuations at the power house, for rapid acceleration is a necessity. All the equipment is heavy. Poles are 30 feet 7 inches high, and braced to an anchor on curves as well as by a strut on the front side. There are two 000 trolley wires, and all the feeders are of 300,000 cm. area. The tension against the trolley wire has been fixed as high as 35 or 40 lbs., and the trolley wheels are 6 inches diameter, but are to be replaced by 7-inch wheels, and they only last one week.

The car wheels are 33 inches diameter and 2⅝ wide on the tread, with 1-inch flanges. Electric brakes are used, and the braked wheels are heavier than the other wheels, weighing 520 lbs., as against 460 lbs. To brake one wheel of a pair does not commend itself as particularly good practice, owing to the severe stresses set up thereby in the axles.

Each car runs 340 miles a day, and the average record of energy consumption per trip is 140 amperes and 565 volts. An average west-bound speed of 43·8 miles per hour was shown, and the same also east-bound; but this was a special test, no stops being made. The maximum speed attained was 55·5 miles. The output of the power house was, for a week ending January 1st, 1899, 3·40 kw.-hours per car mile, and at 6·4 lbs. of coal per kw.-hour the coal consumed was 21·8 lbs. per car mile. This is a high rate of coal consumption, and ought to be remedied, as it compares badly with steam practice. A Great Northern locomotive burns about 23 lbs. per mile with a heavy train behind it, and the locomotive alone weighs nearly double a car, the tender as much more, and there is still the train.

The engines, two in number, are 20 inches and 36 inches × 48 compound condensing, and are so arranged that when they exceed normal speed by more than 10 per cent., a trip gear shuts off the steam, and also operates the trip of the generator circuit breaker. There are two 400-kw. Siemens & Halske generators with outside armature and separate commutator. The plant is attended by two engineers, two firemen, a coalman, of whom the second engineer and one fireman are on duty at night, and it is considered they are still not fully loaded with work. The *Street Railway Journal*, to whom we are indebted for our information, reports some tests made on the plant from which, it appears, that the coal consumption is as high as 12 lbs. per I.H.P.-hour, the water consumption being 16·14. We think the coal consumption is meant to be 2 lbs. The dry coal per kw.-hour is 2·72 with feed at 210. The engine efficiency is 91·05 per cent., that of the generator 91·48, or conjointly 83·3. In daily practice the results obtained were much inferior all round.

At times the overload has been 100 per cent., the circuit breaker acting at 1,100 amperes, and 1,000 amperes being carried for several successive minutes. The use of the four 50-kw. motors on a car of 22 tons may be compared with the practice of the Stockwell line in respect of the quality of acceleration.

WIRELESS TELEGRAPHY.

[CONTRIBUTED.]

RECENT experiments have fairly well demonstrated that Marconi's system of telegraphy is quite reliable for moderate distances under all conditions of weather experienced in England, and there can now scarcely be any doubt that it will be equally successful in other parts of the world.* It will be very useful as an adjunct to the ordinary lines in cases of accidental breaks where there are serious obstacles to restoration, and, we should say, almost necessary in modern warfare, at times when visual signalling cannot be carried on either by stress of weather or owing to the configuration of the country.

* Marconi's experiments have not yet demonstrated that the system is practicable *over land*, and there is some doubt whether it is so or not.—EDS. ELEC. REV.

Flags, heliographs, and flash-lights can, of course, be operated only in the direct line of sight, but, from the experience that has been gained at Cape Grisnez and in the Isle of Wight, it appears that the electrostatic effect is perceptible when transmitted through, or over, large masses of the earth. In such a campaign, therefore, as that of Tirah, the Marconi system would probably have been of value, and will, no doubt, upon the frontiers of India be largely practised. Its success as a regular auxiliary to ordinary methods must depend upon whether comparatively unskilled operators can quickly instal and work it. If experts are indispensable, then in many outlying stations and isolated places, unconnected to the rest of the world by alternative telegraph routes, and which, in ordinary circumstances, are completely cut off by an accident, it would be useless to keep the apparatus in reserve. When it is proved to be as simple to work as appears from the published reports, then we feel sure that it will be advantageous for the military staff and civil signallers at places, such as river, cable, and span crossings, and frontier outposts, to be regularly exercised in its use.

It is well to remember that it is not always easy to elevate a wire to a height of 150 feet to serve as a vertical conductor for telegraphing across such a distance as separates Folkestone from Boulogne, and in places where no timber is procurable, it could only be done by kites or balloons. These necessary appliances, or the means of making them serviceable would, in out of the way places, be generally wanting. We should be glad, therefore, if bye-and-bye it is discovered that readable signals can be exchanged over 10 or 20 miles with conductors of readily attainable height, such as that of a house, or of a few tent poles spliced together, or by wires hanging vertically over precipices, or slung over trees.

Doubtless to those who have had experience of the outposts of civilisation, many occasions will be recalled when, with the aid of the system we are considering, a very welcome solution of pressing difficulties would have been afforded. The rapid communication thus made possible, where ordinary wires have been destroyed, as at Manipur and Cabul, would have been of great value during the military expeditions with which the memories of our readers will readily associate the names of those places.

Where expensive cables have to be maintained in wide rivers, estuaries, and shallow straits, the Marconi system should be very helpful. We would not say that it will entirely supersede short lengths of cables, for it must be remembered that an office staff will have to be maintained at each point where it is worked, and the annual cost will often amount to more than the maintenance of a cable, but there are cases, such as that of the Indo-Ceylon cables, which have been very expensive, in which it might be advantageous to resort to wireless telegraphy at least for one circuit.

There will be, perhaps, more difficulty experienced in the tropics than in England in regard to atmospheric disturbances. Thunderstorms of several hours' duration are not infrequent in hot countries, but we gather from Mr. Preece's remarks at the Society of Arts recently, that lightning does not interfere more with a wireless system than with transmission by aerial conductors, and everybody knows that telegraphy is tedious and troublesome with the latter in such storms. The former is not likely to introduce fresh troubles. It is encouraging to know that a speed of 20 words per minute has been attained by a Marconi circuit, a speed which in many localities abroad is not exceeded in common practice by hand signalling.

Reviewing all the circumstances which have been made public, there is thus every reason to believe that electrostatic telegraphy, if it is able to surmount climatic difficulties, can be easily installed and can be operated by the average signaller, will have a large sphere of usefulness.

Physical Society.—On Friday last, 26th ult., a paper was read on "The Thermal Properties of Normal Pentane," by Prof. S. Young and Mr. Rose Innes. A paper by Mr. C. G. Lamb on "The Distribution of Magnetic Induction in a Long Iron Bar" was postponed until the next meeting.

REVIEWS.

Measurement and Weighing. By EDWIN EDSER. London: Chapman & Hall. 1899.

This is intended as a text-book in the first year's course of elementary practical physics. Measuring and weighing, approximately, are both simple matters which everyone thinks themselves capable of doing, but accurate work is by no means easy, and the student who has mastered the two subjects is at least on the way to understand a good deal more.

The art of measurement may be held to embrace almost anything which comes into the sphere of an engineer's work, and is so recognised by the author, although he limits himself to some of the more elementary processes.

He deals with linear and surface measurements, solids, and also with the instruments employed—the wedge, screw and callipers, the dividers, and the vernier. He shows also the application of trigonometrical methods, the copying of an irregular figure, and the determination of logarithms, sines, cosines, &c.

In the weighing section, which, after all, is but a branch of measurement, he deals with specific densities, and generally the determination of specific gravity by the methods of weight, displacement, or flotation.

The student who carefully works through the book will secure a good knowledge of the subject, as well as considerable experimental experience. We note one error. The English foot is stated not to be recognised as a unit outside England. This is hardly correct. Russia and the United States practically measure in the English foot, and it is certainly quite as good a unit as the pseudo-scientific metre, which is not even what it professes to be, but only a very coarse approximation, after all, to a certain fraction of the meridional arc. We think advocates of the metrical system for commercial use are rather inclined to take wrong views. They do not appear to grasp the significance in this world of the three principal powers it contains.

The Slide Rule. By C. N. PICKWORTH. Fifth edition. Manchester: Emmott & Co., Limited.

This fifth edition has been considerably re-written, and also enlarged, and it is one of the best practical hand-books on slide rule methods. The special form of rule, of which our author treats, is the Gravêt or Mannheim type. It is not all engineers who care to use the slide rule. Others again appear to have a peculiar fitness of mind and become very expert in its use. Engineers who desire to become so expert cannot do better than study this book. Mr. Pickworth himself is, we believe, such an expert. For set calculations involving a series of similar computations slide rule methods are admirable, even for the non-expert, but unless an engineer is determined to make persistent use of his slide rule he will lose his aptness. The slide rule requires to be used steadily and always. When so used it is invaluable. We can recommend Mr. Pickworth as a safe guide.

Practical Dictionary of Electrical Engineering and Chemistry in English, Spanish, and German. By PAUL HEYNE. Dresden: Gerhard Kühtmann. London: H. Grevel and Co.

This is a collection of more than 7,000 English terms used in electrical engineering and chemistry with their equivalents in Spanish and German. The work appears to have been done very carefully and thoroughly, far more so than many other collections of technical terms that we have seen. It should be useful to traders and engineers doing business with Spain and Germany.

Inwood's Tables of Interest and Mortality. By WILLIAM SCHOOLING. London: Crosby Lockwood & Son. 1899.

Tables of interest and mortality are rather for the actuary than the engineer, but nevertheless in many things which come before an engineer it is necessary to have some knowledge of the principles of interest calculation and annuities.

Thus, what is it worth while to pay for an annuity of x pounds per annum terminable in y years? This book helps to solve such questions, and for an engineer the value of x may be so much coal saved by a feed heater and y may be the life of the heater. Then the present value ought to be greater than the price to be paid for the heater or it will not pay to purchase the apparatus. These tables are very full and complete, comprising also some special logarithmic tables which should be useful in the evaluation of annuities, and bear upon the example we cite. To show the ease of logarithmic computation, the editor computes the income per second of each individual of the 1,483 million inhabitants of the earth which would come from the sum of one penny invested at 5 per cent. compound interest for 1,900 years. The individual income per second is no less than the respectable sum of £80,944, followed by 15 cyphers. Moral, save a penny and start. You would have twopence to show the first 14 years.

As an example of the calculation of the present value of an apparatus, assume capital plentiful and worth laying out if 5 per cent. can be secured; let a feed heater be estimated to effect a net saving of £47·25 per annum, and let it be assumed to use Manchester water, or other equivalent soft water, and therefore to have a life of 30 years. Our annuity is thus for 30 years.

Now the present value of £1 per annum for 30 years is by table page 74 = £15·37245, the log. of which is 1·186743. The log. of £47 25 is 1·674402. Their sum is 2·861145, which is the log. of £726·35.

At 10 per cent. the present value is £445·10 nearly. According, therefore, to the value of money, it would pay to put in a large economiser to save £50 per year, and in working out such questions, this book will be useful to engineers.

The tables are all well explained and illustrated by examples.

Practical Work in Physics for use in Schools and Colleges. By W. G. Woollcombe, M.A. (Oxon.), B.Sc. (Lond.). Part IV.—Magnetism and Electricity. London: Henry Frowde.

This is a very good collection of practical experiments in electricity and magnetism for use in schools. The apparatus required is as simple and inexpensive as the circumstances allow, the explanations and diagrams are exceptionally clear, the experiments are sufficiently numerous and are judiciously chosen. We can recommend the book to science teachers who have to arrange an experimental course for a fairly elementary class.

The Entropy Diagram and its Applications. By J. Boulvin. Translated from the French by Bryan Donkin. London: E. & F. N. Spon. 1898.

While doubtless a good and sufficient exposition of the subject for the student of mathematics or for the engineer who intends to make considerable use of the entropy method of investigation, this book will not, we fear, commend itself to the man who is not prepared to give up much time. We fear that the entropy method is too complicated for general use and a trifle narrow in its application, for there is a good deal of calculation to be got through, and an average diagram only can be employed. For such, however, as can find the time the entropy diagram is perhaps excellent as a means of studying heat engines. But the uncertainty is great. Even in this little book the author has to explain certain discrepancies by stating that in one case no cognisance has been taken of the variation of the specific heats of gases at high temperatures. Now it is all very well to fill books with elaborate mathematics, but we should like some good mathematical writer to come forward and put forth his energies to the expounding of the entropy diagram in as simple a manner as the p.v. diagram can be explained. To make of it a mountain while ignoring the variation of specific heats of gases is very like playing Hamlet with the Prince of Denmark left out of the cast. The entropy diagram has been pushed very considerably as an aid in thermo-dynamic solutions, but as no very great steam engine improvements have been made by ultra-scientific men, it were a pity not to make an endeavour to put the method within the reach of the practical man who is familiar with the indicator method, and can work out fairly satisfactory results by the more ordinary methods, and cannot—even if he has the ability—find time to study up the entropy diagram.

CORRESPONDENCE.

Experiments with the Caldwell Interrupter.

One of the most striking phenomena exhibited by this apparatus, and which may give the key to the explanation of the action which goes on at the point of interruption, is the way in which the acid is drawn through the orifice from one vessel to the other under certain conditions.

In these experiments the interrupter was constructed as follows:—A large vessel filled with strong acid contained one electrode; a glass tube of ½ inch internal diameter containing the second electrode was placed in the larger vessel, the tube having orifices of various size and shape. In almost all cases the acid was drawn rapidly through the orifice, and rose to considerable height in the tube above the level in the larger containing vessel.

This rise in the inner vessel did not appear to be affected by the direction of the current. It increased very rapidly with the E.M.F. employed, the following giving the mean of several measurements with an aperture of about 1·5 millimetres diameter in the extremity of the ½-inch tubing. Very consistent results were not obtainable, nor would exactitude be of any value, as very slight alteration of the conditions, to be explained later, greatly modified them.

E.M.F.	Current.	Rise in centimetres.
55	2·5	1·5
75	3	10
95	3 5	25
110	4	50
130	4	90

These results were obtained when a 6-inch spark induction coil was placed in series with the interrupter. When this coil was removed, the rise, as also the frequency, was somewhat reduced. But with the much greater inductance of a transformer in series, both the frequency and the rise were also greatly reduced.

During prolonged working the orifice gradually increased in size in a very curious manner, the edges appearing as if ground away, and an irregular orifice becoming perfectly circular. The increase in size naturally increased the current, while the frequency was reduced. The frequency also increased somewhat as the acid rose in the tube.

The size of the orifice did not appear to greatly affect the rise in the tube, though a great many were tried up to a diameter of 2 mm., nor did it seem to matter much whether the orifice was in the side or extremity of the tube. An attempt to use a J-shaped tube resulted in the acid being drawn downwards initially as easily as upwards, but the collection of steam beyond the bend soon broke the circuit and produced frequent small explosions. The approach of a piece of glass close to the orifice externally reduced the rise in the tube. An orifice at the end of a tube drawn out to a slightly conical shape gave a very great rise, but on cutting off this cone, and fusing it into another piece of the tube so as to obtain an inward pointed cone with the minute orifice at the end, I succeeded in reversing my previous results, and causing the acid to be drawn out of the inner vessel into the outer. Even then, however, if I caused the acid to rise a few inches into the inner tube by deeper sinking, it would continue to rise still further; but if I brought the end of the tube near the bottom of the outer vessel the acid was again sucked out. It seemed, therefore, that the acid would be drawn into the vessel which most obstructed its free flow from the orifice.

My results appear to be very naturally explained in accordance with the hypothesis suggested by Mr. C. T. Child, in this week's Electrical Review, in the following way:—Supposing that the contraction of the surfaces of the acid when separated by the bubble of steam in the orifice

is much more rapid than the separation during the formation of the bubble, the acid will be forced outwards from the orifice more or less equally into either vessel, while the more sudden flow of contraction will be modified by the inertia of the acid. From the one vessel, generally the inner or smaller, a larger amount of momentum has to be imparted to produce the requisite flow, and the place of the ejected bubble will be filled mainly with acid from the vessel into which the lines of flow spread out most rapidly, generally the outer. Thus the acid will advance with successive impulses into the inner vessel, until the increased pressure causes the expansion of the bubble to push the acid outwards only. Any blocking of the free access of the acid externally causes a reduced inward flow, while, as in the last experiment above, a longer column of acid in the tube increases the momentum of the acid when ejecting the bubble, and thus causes an inflow.

This theory was further confirmed by placing a large test tube in the outer vessel, and the orifice tube was sunk into this test tube. The latter vibrated as if attracted and repelled with each interruption, beating upon the bottom of the outer vessel.

A. G. Cooke,
Head of Physics and Electrical Engineering Department, Battersea Polytechnic.

May 27th, 1899.

Block Signalling for Single Line Railways.

I have very carefully read the description in this week's ELECTRICAL REVIEW of the electric interlocking for single lines which, it is said, is intended to replace the tablet block, and is as safe and applicable for non-crossing stations as the arrangement which was designed by myself, and described in a recent number of the ELECTRICAL REVIEW.

It is possible that I may not clearly grasp all the points of this electric interlocking, and I should like, therefore, to ask firstly, if the Board of Trade have sanctioned the use of this electric interlocking for single lines perfectly independent of, and in lieu of, the train staff or tablet apparatus? Secondly, as interlocking is usually intended to absolutely prevent a signalman from doing wrong, does this arrangement absolutely prevent the signalman at C (when the rail contact z, at B, has been operated by a train from A, and the signal levers are all back in their normal position), by mistake or otherwise, accepting a train from D? If so, how is this done?

The description of this locking states as follows:—"The train on arriving at B, and passing over the treadle z, takes the forward locks off both the starting signal lever 2, at A, and the home signal 4, at B; these signal levers *can now be returned to their normal positions, and the line will then be free for a following train.*"

Supposing, now, the train has arrived at B, and there are sidings at this place, and the train is shunting about, and the signalman forgets it, and as all the signals, plungers, levers, and switches are in their normal position (that is, in the position in which they were before this train was accepted from A), what is there to prevent C accepting one from D?

I have every confidence in Mr. Sykes's devices for electric interlocking, but I shall be glad to hear that it is not possible to lose a train at B, and C be able to accept one from D.

F. Hollins.

Electric Piping.

On reading the letter signed "J" in your impression of the 26th ult., I cannot help but think how well his own letter illustrates the ambiguity which exists not only amongst architects and the general public, but also those who profess to know something about it, especially himself.

I do not wish it to be inferred that I blindly approve of any particular system of wiring to the exclusion of all others, as I feel sure that insulated iron barrel, plain iron barrel, and what is known as Simplex conduit all have certain advantages for particular cases, but for a general all-round system which lends itself to all classes of buildings I feel sure that twin lead-covered wires cannot be improved upon. They are easily and very cheaply protected where additional mechanical protection is necessary, which is in very few cases, and their safety cannot be disputed. The only harm that can possibly come to them would be that specified by your correspondent "J" through careless or clumsy workmen; and it might be of interest for it to be known in Edinburgh that London contractors do not employ navvies or bricklayers' labourers to fit up electric light wires.

B. H. Jenkinson.

May 30th, 1899.

Capacity Measurement of Long Submarine Cables.

Mr. Dearlove* has not, evidently, grasped the true import of the difference which the method I have suggested makes, both to the convenience and correctness of the slide form of capacity measurement. The tables he gives prove this very clearly. It will be noticed he uses reversals, applies a correction, and is forced to make a number of corrections for every test.

The reversals are necessary, because the E.C. is not otherwise neutralised.

The correction is a consequence of the facts (1) that reversals are used; (2) that the D.R.'s per micro. are not equalised; (3) that the "Muirhead method" is not a null one.

A number of observations are required, because the E.C. is variable, and the "discharge" and "reproduction" deflections are consequently also variable.

It is fairly obvious that in the cases he cites, the D.R.'s were nearly balanced, otherwise an alteration of the time of charge would have caused a greater divergence of his results. In any case his most constant results were obtained with the longer periods of charge, a fact which I beg will be borne in mind when what follows is considered.

It is absurd to say that the time given to "mix" is unimportant in Muirhead's method, because the correction depends entirely on the quantity remaining after mixing, and unless this is measured immediately it follows that some of that quantity will be lost by leakage, and the resultant correction will be too small.

That alteration of "mix period" did not, in his cases, affect the results to any important extent, is only another indication that the D.R.'s were nearly balanced, and that the correction was, therefore, small. But if with nearly a balance of D.R.'s he obtains such good results, why not come with me a step further, and, by balancing the D.R.'s exactly and prolonging the time of charge until the period of "unrest" has passed, do away with the correction entirely.

The existence of a correction destroys the nullity of the "slide method."

Reduced to its simplest, my argument is that the test should be taken when the curve representing electrification of the cable becomes sensibly horizontal.

It has been the practice hitherto to attempt to test whilst the electrification was at its "perpendicular" period. By allowing the charge to continue until the change rate becomes very slow, and arranging that any loss of free charge, due to absorption or leakage, shall be continuously replaced (by connecting the battery to each of the compared condensers), the test is made when the potentials throughout the system have assumed a practically steady value, and a calm, unhurried measurement may then be obtained. If Mr. Dearlove would give my plan a trial, I am sure he will ever after "use no other."

I am glad to find that Mr. Dearlove confirms my conclusion that the effect of temperature upon the true capacity is not appreciable, but I would suggest that it might be interesting to repeat his comparisons of gutta-percha core coils, taking into account any difference the variations of D.R. may make, either to the ratios of the D.R.'s *per se* or to the resultant ratios of the slide arms. It is a question I mean to investigate if even laboratory tests are free from error in this respect.

I find the slides themselves are apt to vary in their leakage, and in the resultant position of that leakage to seriously affect the values obtained.

Condensers (fig. 1) also have the effective leakages thus:—

l^1, l^2, l^3,

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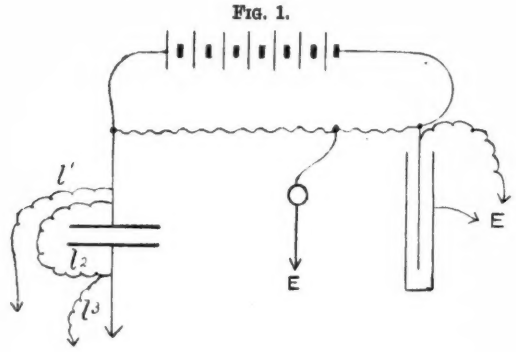
* ELECTRICAL REVIEW, May 19th, 1899.

a fact which points to the desirability of reverting to Lord Kelvin's original connections, because the leakages throughout the system would then be more probably symmetrically distributed. Battery leakage (the *raison d'être* of the so-called Gott's form) can easily be provided against (fig. 2).

Fig. 1.



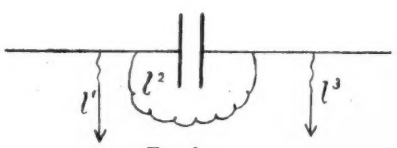


Fig. 2.

The three condenser leakages are thus reduced to one effective leak.

With regard to a "standard time," I have shown such a thing to be unnecessary as far as capacity testing is concerned. Mr. Young referred to it in connection with conductor resistance tests.

My view is that in that case, also, the time of charge given should be sufficient to allow the electrification to settle down. The D.R. operating when such is the case, can be calculated from the observed C.R.'s by formulæ published by me in the *Electrician*, August 12th 1898.

Walter J. Murphy.

Vigo, Spain, *May 27th.*

WATER-TUBE BOILERS FOR THE NAVY.

Mr. William Allan, of the Scotia Engine Works, has been a consistent opponent of the use of water-tube boilers in the Royal Navy. He had the courage of his convictions in regard to the *Terrible* and the *Powerful* long before these failures were placed in commission, for he denounced the intended application to them of water-tube boilers. The Electrical Review stood almost alone among the technical papers in doing the same thing, and, as we have already pointed out, events have unfortunately proved that we were right. In a recent issue of the *Pall Mall Gazette* Mr. Allan criticises certain statements made by anonymous correspondents who have ventured into the fray. A shipowner who ventured to express his views on water-tube boilers before the Institute of Naval Architects, and who put water-tube boilers into two steamers he recently built, is asked by Mr. Allan to be so kind as to furnish figures and to explain why the boilers are to be replaced.

Mr. Allan comments on Admiral Rawson's complaint as to the smoke signals made by water-tube boilers, and he attributes this to the almost direct vertical line from fire grate to funnel, which we all know to be fatal to smokeless combustion, preventing, as it does, the proper admixture of air and gases as well as too quickly cooling down the furnace gases below ignition temperature. Expensive to construct and wasteful of coal, Mr. Allan sees no compensating advantages in water-tube boilers which, in spite of elaborate safeguards and delicate nursing are at all times uncertain and dangerous in the extreme, and he roundly condemns them as the most erratic type of steam generator. He compares them with the ordinary boiler, which only carelessness can cause to seriously explode, and points out that engineers and stokers do not trouble their minds as to the liability of failure, so rare are these occurrences.

Sir John Durston himself only allows six years of life to a water-tube boiler. What then, asks Mr. Allan, is to be gained to justify the abnormal expenditure this entails. It is not economy; it is not simplicity; nor is it freedom from smoke or any reduction of engine room or stokehold complements. On all these essential points water-tube boilers fail in a comparison with ordinary shell boilers.

In time of war such an explosion as recently occurred on the *Terrible* would produce utter demoralisation and probable grave disaster to the ship. We hear it argued that a shell exploding in an ordinary boiler will cause this also to explode. Now, if shells are going to explode within any boiler there will be a second explosion, that of the boiler itself, and if one shell does explode it will be, to use a slang phrase, a case of "let 'em all come," for there will be very little to say after the first. But a good stout shell boiler might deflect some of the lighter shells and ward off an internal explosion, so that very little can be urged *for* the water-tube boiler on this score. We have already characterised the adoption of water-tube boilers as a too large and doubtful experiment on the score that no one had a right to play tricks with the navy, for the country cannot afford it. The country can and will afford the best boilers possible, but they must be the best, and not adaptations from the French. We cannot do better than quote Mr. Allan's closing paragraph, and commend it to our readers:—

"Notwithstanding the minimising tactics of the Admiralty, the day will come when this fatuous boiler policy of theirs will be seen in a fleet of crippled ships, for which large sums of money have been ungrudgingly voted by the country; ships which, instead of being designed and equipped on the soundest and safest engineering lines, have been made use of to exploit a steam generator on which about two millions have been spent, being deemed by the Admiralty the best type for warships, but now, alas! proving itself to be not only totally unsuitable for such vessels, but a positive menace to their safety and efficiency."

We believe Mr. Allan is correct in his statements, and trust that his words, backed up by practical proof of the insufficiency of the boilers he condemns, may obtain a better hearing than they have hitherto done.

The Admiralty have a character for standing still. They had better do this than tumble headlong in their blindness into unproved designs. No one has yet been able to come forward before any body of engineers and tell a satisfactory tale of the behaviour of water-tube boilers at sea. The reason is obvious. There is not yet a really satisfactory water-tube boiler for marine purposes.

We are glad to find that the unstinted recognition by the *Engineer* of the water-tube boilers of the *Powerful* and *Terrible* has at last been somewhat modified. Russia, Holland, and, acting for Portugal and Norway, Elswick, have all largely adapted a modified form of the Yarrow type of boiler for large vessels. Six Dutch cruisers of 10,000 H.P. each, and a couple of 6,000 H.P. battleships, and three torpedo boats of 1,000 H.P. each have been or are to be fitted with these boilers, while the *Don Carlos*, for Portugal, of 4,350 tons will have 12 Yarrow boilers of 12,700 H.P. of engines, and two Norwegian ironclads of 3,850 and 4,500 tons will be similarly equipped.

The *Engineer* publishes figures given by the Dutch Government showing coal consumptions per I.H.P.-hour of the cruiser *Friesland* of 1·62 lbs., 1·67 lbs., and 1·84 lbs. As regards weight per H.P. developed while the Belleville boilers of H.M.S. *Diadem* weigh 97 lbs. per I.H.P., the four Yarrow type boilers of a Japanese destroyer of 6,500 H.P. only weigh 25 lbs. per I.H.P., including mountings and water. Each of the 30 boilers of the *Diadem* gives only 575 H.P., whereas the Yarrow boiler gives 1,600 H.P.

The *Engineer* now points out that between 25 lbs. and 97 lbs. there is a wide margin for additional tube thickness and durability, so that the evil of pitting may be less proportionally severe, and comes to the conclusion that there is no valid reason why such modified Yarrow boilers should not displace the Belleville or Niclausse types in safety and durability, types of foreign invention, and our contemporary is even satisfied that we need not go to foreigners for a good water-tube boiler. Now we still are of opinion that the English Navy should not be made the playground of crude experiment. Here, however, we find that foreign navies are adopting English engineers' designs, while the English Navy has gone to France for its water-tube boilers and found them failures. Seeing that English water-tube boilers had already proved successful in torpedo boats, it seems a pity that the huge experiments of our own large cruisers should have been undertaken on what cannot have been sufficient basis of experience.

Apropos of the water-tube boiler in the Navy, it appears that special provision is to be made for the storing of the boilers of destroyers in the reserve. Tubes which fail by splitting, perforation, or corrosion are to be specially reported upon. This refers to condenser tubes, some of which have failed when blown upon by drain and other pipes, and special fittings are to be used to prevent this. All this very special safeguarding points to the delicacy of the modern boiler and to the great care necessary to keep them going. The *Naval and Military Record* says that the most alarming fears have not been realised and that adequate steps have now been taken to minimise the chance of accident. Let us hope so. The leakage from corrosion or other sources of condenser tubes will soon ruin a water-tube boiler by the introduction of salt into the boilers, and this is one of the delicate features of such boilers, and one which makes its adoption still so much a matter of experiment not to be lightly undertaken on too large a scale.

WAVE MOTORS.

The generation of power from the rise and fall of tides, or from that of waves, has been long a problem attracting the attention of inventors. But though the notice it has received has been great, up to the present time no practical solution has been found, and with the exception of bell-buoys rocked by the tide, the enormous aggre-

gate power that is developed daily on our coasts is still unutilised by man.

The improved methods of generation and transmission of power that have resulted from the development of electrical engineering during the last 10 years, have led to renewed attempts to make use of this wasted energy, and in America inventors have carried some of these proposals to practical trial. The following details of what has been achieved are abstracted from an article which appeared in a recent issue of *Electricity*, New York (February 15th, 1899):—

The Wright wave motor was tested on the Pacific coast at Potencia in 1897. A wharf 26 feet in width was built, and several motor floats were placed around it. The motion of the waves caused these floats to pump water into a closed tank, and the pressure generated in this way was used to drive a Pelton wheel and an attached dynamo. The apparatus worked well and generated a constant pressure in the water supply tank of 250 lbs. The disadvantage of this system of generating power from the waves is evidently the necessity for a wharf to carry the storage tank and generating machinery.

In 1898 J. H. Bunnell obtained a patent for a wave motor, which is stated by the inventor to be an advance upon the Wright motor float. The chief distinction between the two forms is that the Bunnell wave motor carries its own pumping apparatus, and the water is carried from the pump by a flexible supply pipe to the storage tank. The pressure generated in the latter is then used to drive a Pelton wheel and dynamo as before. It does not appear that the Bunnell motor has yet been tested at any point on the Western coast.

At "Ocean Grove" on the Atlantic seaboard, however, a third form of wave motor, designed by H. E. Rider, has been on trial. This differs from the previous two, in that, levers are dispensed with, and the rise and fall of the waves is made to actuate a vertical piston ending in a float, and working in a stationary moored air compression cylinder. The apparatus with which the trials were made at Ocean Grove weighed only a few hundred pounds; the air cylinder was 2½ feet long by 3 inches diameter; and the compressed air was conducted to the shore by a flexible rubber tube and gas-pipe 600 feet in length. The pressure obtained by this apparatus is stated to have been 20 lbs. A company is exploiting this patent, and will organise trials on a larger scale during the present year.

All the above forms of apparatus are designed for the utilisation of the power represented by the difference in height between the crest and hollow of successive waves. Taking the mean height and periodicity of the waves at any point on the Atlantic seaboard, it would therefore be possible to calculate the maximum energy that one may hope to obtain from such wave motors, and the economic possibilities of these methods of power generation. So far as we know this has not been done, and inventors rarely work out the efficiency or the actual cost per H.P. of their devices for obtaining power from the waves. If they made these calculations they would probably find that the value of the power generated would hardly balance the interest upon capital outlay, and cost of supervision, repairs, &c.

In conclusion, we may refer our readers to a "Note" in our issue of January 6th, 1899, in which we gave some details of T. Edison jun.'s plan for utilising the tidal energy of Long Island Sound.

We have received no further details of the proposed trials of the Edison apparatus, but, judging from the faith which all good Americans have in the name of Edison, we have no doubt that versatile young man has obtained the necessary capital for trial of his scheme.

These facts and details prove that although the problem of the utilisation of tidal and wave energy is not yet solved—even in New York—it is receiving considerable attention, and that practical trials are being made of the more promising forms of wave and tidal motors. The trials would seem to show that already self-lighting electric buoys for marking channels and banks could be successfully designed, and we have no doubt that within the next 20 years the generation of power on a comparatively large scale from wave and tidal action will become as practicable as the generation of power from falling water. Whether it will prove such an economic success we shall not presume to prophesy.

BUSINESS NOTICES, &c.

Auction Sale.—Mr. J. E. Lambert is to sell by auction on Monday, June 12th, the whole of the electrical plant, dynamos, motors, gas and steam engines, &c., &c., at the Kelvin Electrical Works, Weir Street, Blackburn. See our small advertisements.

From our advertisement pages particulars may be obtained of an auction sale, to be conducted by Messrs. Hincks & Shakespear, of the stock-in-trade, plant, and patent rights of the Central Electrical and Engineering Company (Charles & Blackwell).

Bankruptcy Proceedings. — The first meeting of creditors in *re* E. L. Joseph, electrical engineer, will be held to-day, June 2nd, at 12 noon, at Bankruptcy Buildings, Carey Street, W.C., and the public examination will come on at the same place on June 30th, at 11.30.

The first meeting and public examination in *re* H. J. Wimshurst, electrical and motor car engineer, will be held at Coventry County Hall on June 2nd and 5th respectively.

The *London Gazette* contains notice of intended dividend in the case of G. F. Rogers, electrical engineer, of Notting Hill and E.C. The last day for receiving proofs is June 13th. Mr. E. B. Lumb, 85, Gracechurch Street, E.C., is trustee.

Notice is given of release of trustee (Mr. A. H. Wildy) in the case of S. B. Tatham, electrical engineer, of Thurlow Place, South Kensington.

Electrical Wares Exported.

WEEK ENDING MAY 31ST, 1898.		WEEK ENDING MAY 30TH, 1899.	
Antwerp	Value £36	Antwerp	Value £82
Brisbane. Elec. fuses	50	Auckland	146
Buenos Ayres	24	Bombay	28
Calcutta	70	„ Teleg. mat.	22
Cape Town	198	Boulogne	27
Christiana	33	Brisbane	287
Colombo	811	Buenos Ayres	23
Durban	211	„ Teleg. wire ..	159
East London	400	Calcutta	109
Fremantle. Elec. fuses ..	50	Cape Town	10
Geraldton	99	Copenhagen. Teleg. cable ..	820
Gothenburg	59	Durban	2,050
Hamburg	20	Fremantle	28
Havre	15	Gothenburg	48
Madras	15	Hamburg	140
Melbourne	65	Hong Kong	10
Port Elizabeth	227	Lyttleton	18
Rangoon	44	Mauritius	90
Rouen	230	Ostend	20
St. Petersburg	42	Port Elizabeth	200
Shanghai	266	Rotterdam. Teleg. mat. ..	290
Singapore	1,292	Shanghai	500
Sydney	85	Singapore	47
Trinidad	21	St. Petersburg. Teleg. mat. ..	232
Wellington	117	Stockholm. Teleg. mat. ..	140
Yokohama	30	Sydney	190
		Trinidad	25
		Wellington	257
		Yokohama	51
Total ..	£4,010	Total ..	£5,344

Foreign Goods Transhipped.

Shanghai. Teleph. mat.	Value £6	Brisbane. Teleph. appts.	Value £739
Trinidad. Teleph. mat. ..	56	Wellington. Elec. lgt. „ ..	72
Total	£62	Total ..	£811

Books Received.—"A Text-book of Mechanical Engineering," by W. J. Lineham. Third edition, revised and enlarged. Chapman & Hall, Limited, London. 12s. 6d.

"Mechanics Applied to Engineering," by John Goodman. Longmans, Green & Co., London. 7s. 6d. net.

Change of Address. — Messrs. Lehmann Bros. are removing from 38, Hampshire Street, Torriano Avenue, N.W., to newly built premises, Hampshire Works, Walthamstow.

Charge of Fraud.—At Bow Street, before Mr. Lushington, last week, Luigi Armanni, mechanical and electrical engineer, of Warwick Court, Holborn, was charged with fraudulently abstracting and consuming electricity belonging to the Metropolitan Electric Supply Company, Limited. Mr. R. D. Muir supported the summons on behalf of the company; Mr. Lloyd Humphreys defended. Mr. Muir said that the defendant was a customer of the Metropolitan Electric Supply Company, Limited, and he had been supplied with electricity by the company since May or June, 1898. But although under his contract he was fitted with 10 16-C.P. electric lights, and had 12 lamps, his consumption of electricity, as registered by the meter, was remarkably small, his account for the Midsummer quarter last year being only 2s. 5d.; for Michaelmas £1 9s.; and for the Christmas quarter £1 3s. 9d. Up to March this year he had consumed apparently only 11 units, and from then until May 4th only three units were registered. Whenever (says the *Times* report) a meter reader called he was refused admission unless the defendant was at home. On May 10th, however, a wireman named Oliver succeeded in gaining admittance, and found that one lamp was plainly connected with the supply main before it reached the meter, and that in the fuse boxes the fuse wire had been removed and another wire inserted. This wire had been connected to the lamps, and it was evident that the current had been short-circuited so as to prevent the electricity passing through the meter, an arrangement which could easily be effected by a professional electrical engineer like the defendant. Under the Electric Lighting Act of 1882 an offence of this kind was punishable as a simple larceny, as in the case of thefts of gas, but it was far easier to steal electricity than to tap a gas pipe. The larceny in this case amounted to a rather considerable sum.—Frank Oliver, the wireman, gave evidence in confirmation of this statement, and evidence was given that defendant had burned five or six lamps all day long, and sometimes up to 11 at night.—The hearing was adjourned.

Charges. — At the Guildhall last week, H. Adams, electrician, was further examined on a charge of conspiring with another, not in custody, to obtain electric light cables, &c., by false pretences from Mr. J. F. Phibbs, electrical engineer. The case was again adjourned.

On Tuesday, at Marlborough Street, J. McCarthy, F. Abrams, and H. Fisher, were committed for trial on a charge of stealing electrical fittings.

Electric Launches.—An electric launch (the *Magic*) has been built for the River Dee police, and has had a trial trip. It was built by the Dee Boating Company, the electrical equipment being carried out by Mr. F. J. Jones, of Chester.

Elmores.—It is stated that the English Electro-Metallurgical Company, Limited, formed under the auspices of Messrs. L. Hirsch & Co., for amalgamating the Elmore copper companies, was registered on Saturday, with a share capital of £700,000.

Liquidations, Dissolutions, and other Notices.—A meeting of the Automatic Electric Meter Syndicate is to be held at Pearl's Assurance Buildings, St. John's Lane, Liverpool, on June 26th, to hear an account of the winding-up from the liquidator, Mr. Gordon Sales.

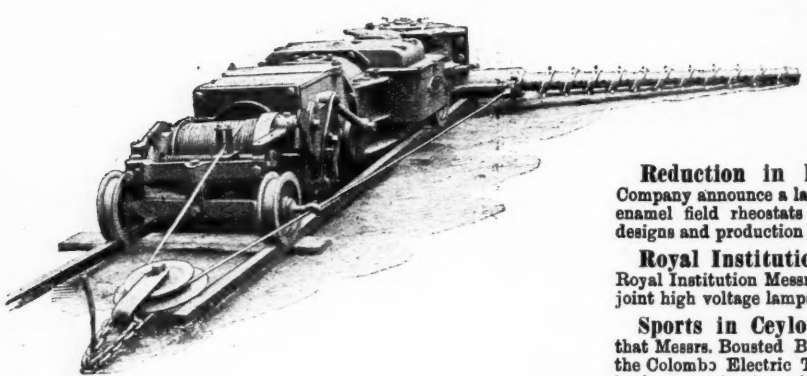
The first meetings of creditors and contributories in the Electric

Exploitation Company will take place on June 6th at 33, Carey Street, W.C., at 11 and 11 30 a.m. respectively.

At a meeting of Messrs. Nalder & Hilton, Limited, on May 15th, it was decided to wind up, Mr. A. E. Darville, of Trafalgar Works, Bow Common Lane, E, being appointed liquidator.

A meeting of the Hastings and St. Leonards-on-Sea Electric Light Company will be held at Queen's Hotel, Hastings, on July 8th, to hear an account of the winding up from the liquidator, Mr. J. Woodhams.

Electric Coal Cutting.—We illustrate below the Hurd patent electric coal cutter, which is being manufactured by Messrs. Mavor & Coulson, Limited, of Glasgow. It can be applied to either a disc or bar cutter, but the latter is preferred, as it affords many advantages, as by reason of its higher speed it is the more suitable form for driving by electric motive power, gearing for only a single reduction in speed being necessary. The bar is made of the best quality of mild steel. It is tapered and has a spiral thread formed upon it. Steel cutters of an extremely simple form, easily made and sharpened by colliery blacksmiths, are fixed along the bar on or between the threads according to the width of holing required. The thread acting after the manner of a worm conveyor brings the bulk of the cuttings from the holing, and leaves ample space for the coal to drop. In addition to the rotary motion of the bar, a reciprocating



motion is introduced giving a combined chipping and shearing action on the coal, greatly reducing the strain on the machine, reducing the number of cutters on the bar, and effectually preventing it from clogging. When at work the bar is necessarily close to the solid coal, and there is no chance whatever of its being choked or jammed by the coal coming down immediately it is undercut. With a disc or chain cutter this is one of the greatest sources of trouble, and is the main cause of breakdowns by overloading the motor. With a soft coal it is usual to cut with the bar at the back of the machine, and thus if a fall takes place it is behind, and no time whatever is lost in ridding the machine of coal or dirt. The bar with its gearing is carried in a turntable in such a manner that it may be swung in and out of the holing, or tilted up and down when at work, the advantages resulting being—(1) The machine is both right and left handed, that is, the bar will cut at either side; (2) It cuts itself into the face when required without the necessity of having to make a jib hole by hand labour; (3) The cutters are very easily examined and replaced, the whole bar being exposed to view; (4) The cutter bar can be raised or lowered at the will of the machineman, and the holing thus made in the best position. By tilting the bar the cut is made to suit the dip or rise of the seam, and small hitches or faults offer no impediment to good cutting; (5) The cut can be made either on the pavement or close to the roof, or at any intermediate part of the seam. Thus only one pattern of machine is necessary for a colliery working several seams of a different nature. The motor is entirely enclosed and protected against dirt or damage from falls of roof. Carbon brushes are used and run practically sparklessly. One of these motors has run 16 months without any repair whatever, and is still practically as good as new. Compared with a disc machine having same depth of undercut and speed of travel, a much smaller motor may be used with corresponding reduction in cost of generating plant. The ordinary pawl and ratchet wheel feed gear is used, with the addition of a simple arrangement for regulating the speed of travel without stopping the machine. A guide gear is fitted to lead the haulage rope evenly on the drum, and do away with the troublesome setting of props ahead of the machine usually adopted for this purpose. It is claimed that with this machine great cutting capacity and freedom from breakdown has been attained.

Lists.—From the Edison & Swan Company we have received a supplementary copy of their electrolier list in which we find illustrations of some very neat and artistic designs of electroliers, pendants, brackets, and other fittings.

We have received a capitally illustrated catalogue (No. 10) of the Clayton air compressors, giving descriptions of these machines in their use for various purposes.

Nernst Lamp.—An important conference was held at Berlin last week, at which the holders of the patents for the whole world attended. The conference lasted for many hours, and the protocol embodying the understanding on all points was signed by those present. There were present Prof. Nernst; Mr. Rathenau, of the Allgemeine Gesellschaft; Mr. George Westinghouse, of Pittsburg; Dr. Von Hoor and Czerhaty, of Ganz & Co., Buda-Pesth; Mr. James Swinburne and Mr. Bernard Drake, of the Nernst Electric Light, Limited. It is claimed that the deliberations at the conference will have an important bearing on the future of the electrical industry.

Personal.—Mr. V. A. Fynn (late of Messrs. Brown, Boveri & Co., and late of Messrs. Easton, Anderson & Goolden, Limited) has joined Messrs. Rosling & Appleby as manager of their designing, drawing and testing departments. Messrs. Rosling and Appleby are now manufacturing both direct and alternating current generators and motors under Mr. Fynn's patents. Many machines made under these patents have for a long time past been running and giving satisfactory results, not only in private installations but also in some of the principal electric light and power stations at home and abroad.

We understand that Mr. J. Place, who has been connected with the Linotype Company for the past ten years, latterly as works' manager and chief engineer, has joined the firm of Messrs. Wheatley, Kirk, Price & Goulty as a partner. His connection with the Linotype Company in his old capacity will cease from June 30th, but the board is endeavouring to retain his services permanently for consultative purposes.

Mr. Percy B. Wilson, secretary of the National Electric Free Wiring Company, has severed his connection with that company and joined the British Electric Works Company, Limited, of Stellite Works, Birmingham, in the position of secretary. Mr. Wilson had been with the National Company from its commencement.

It is stated that Mr. T. J. Coad, who has been assistant at Falmouth Observatory, has received an important mining appointment at Johannesburg as electrical engineer.

Reduction in Price.—The Ward Leonard Electric Company announce a large reduction in the price of their Carpenter enamel field rheostats and theatre dimmers. This is due to new designs and production in very large quantity.

Royal Institution.—At last Friday's meeting of the Royal Institution Messrs. Gabriel & Angenault exhibited their triple joint high voltage lamps and other specialities.

Sports in Ceylon.—From the *Ceylon Standard* we see that Messrs. Bousted Brothers' engineers and employés have formed the Colombo Electric Tramway Sports Club. Cricket, football, and hockey captains have been appointed, and play has doubtless been begun by this date at Price Park.

Thames Ironworks.—A petition to confirm resolutions passed by shareholders of the Thames Ironworks and Shipbuilding Company, Limited, altering the name of the company to the Thames Ironworks, Shipbuilding and Engineering Company, and adding to the company's objects in the articles of association will be heard on Wednesday, June 7th, by Mr. Justice Wright in the Chancery Division.

Trade Announcements.—As will be seen from our "New Companies" registered Messrs. D. H. Bonnella & Son have formed their business into a limited company, under the style of Messrs. D. H. Bonnella & Son, Limited. This arrangement has been effected solely for family reasons, and the business will be carried on under the same management and on precisely the same lines as before. Increase of business has necessitated taking additional premises for offices and stores at Mortimer Street, and for works at Kirby Street.

Messrs. Heaton & Smith, of Salford, have also converted their electrical fittings business into a private limited company under the style of Heaton & Smith, Limited, with a view to consolidating and extending their trade. The showrooms, offices, supply and stock departments are all situate at 7, Blackfriars Street, Salford.

Tudors, Mash & Co. v. Headland's Patent Storage Battery Company and others.—In the Queen's Bench Division of the High Court of Justice, on Tuesday, before Mr. Justice Mathew, the case of Tudors, Mash & Co. *v.* Headland's Patent Storage Battery Company, Limited, with Messrs. Walker, Parker & Co, Limited, came on for further consideration. Mr. Fletcher Moulton, Q.C., and Mr. Peel were for the plaintiffs, who claimed £75 for red lead and litharge delivered to the defendants; Mr. A. O'Connor, Q.C., and Mr. Eldridge were for the defendants, who counter-claimed because of the defective character of the material supplied, which was for the purpose of installing electric motive power on barges belonging to Messrs. Lever Bros. Sunlight Soap Company at Port Sunlight, on the Mersey; and Mr. Robson, Q.C., and Mr. Haldenstein were for Messrs. Walker, Parker, the third parties, who had supplied to plaintiffs the goods which they in turn forwarded to the defendants. At the previous hearing his Lordship gave judgment for plaintiffs on the claim, and for defendants on the counter-claim. The matter now came up on the question of the amount of the counter-claim, and his Lordship, after hearing evidence, gave judgment for the defendants (the Headlands Company) for £425, less £65, in respect of the litharge delivered, and adjudged the liability of the third parties to the plaintiffs at £115.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Gas and Electric Lighting Committee last week decided to borrow £15,000 for electric lighting purposes.

Aston Manor.—The *Contract Journal* says that the destructor which was erected in 1892 having proved insufficient for the work, the Urban District Council have now decided to add four cells on the Beaman & Deas pattern, and to make other alterations by which its capacity will be improved to 108 tons daily. The steam will be obtained entirely from the heat generated in the destruction of refuse, but should the cells be allowed to go out or be cooled down for cleaning or repairs, the steam can again be started by means of auxiliary grates. The power will be distributed electrically by means of cables carried from one central generator to motors fixed wherever required. Separate motors will be fixed to work (1) the fans for the air blast in the cells, (2) the elevator, (3) mortar mills, (4) well pumps; a small one will be set up in the stables for chaff-cutting, The present boiler will be used for heating the fire station with steam. The wharf and premises will be lighted throughout with electric light, and the disinfecting apparatus will be worked by steam from the boilers. The estimates have been increased from £11,500 to £14,000. It is proposed to put a dynamo of 130 H.P. in the engine house, and by means of cables to transmit the power from it to the motors at the grinding mills, elevator, fan, well pumps, and chaff-cutting machinery, as well as electrically lighting the yard, fire station, and other buildings, the estimated cost being as follows:—One 130-H.P. multipolar generator, £430; one 25-H.P. motor for grinding mills, £150; one 10-H.P. motor for elevator and conveyor, £90; one motor for fan, £100; one 10-H.P. motor for well pumps, £98; one 5-H.P. motor for chaff-cutting, £70; cable and electric motors, £100; electric lighting, 22 arc lamps and 68 incandescent, £365; main switchboard, £65—making a total of £1,468. The works will be divided as follows:—(Contract No. 1) the destructor cells, flues, boilers, &c.; (2) engines, generator, and electrical plant, pumps, and storage tank; (3) elevator and conveyor; (4) buildings and paving; (5) well and boring; and (6) disinfector. The Local Government Board have been applied to for a loan of £14,000 (machinery, £4,931; buildings, £9,069), and tenders for the works as above will be advertised for.

Asylum Lighting.—The contract for the electric lighting of the City of London Asylum, at Stone, near Dartford, has been given to Messrs. Mavor & Coulson. The work is being carried out to the specification of Mr. A. A. Campbell Swinton, M. Inst. C.E., the consulting engineer to the Visiting Committee.

A proposal to spend £24,000 for providing an electric light installation at Rainhill was defeated when it came up before the Lancashire Asylums Board.

Barnsley.—The Board of Guardians is considering a scheme to provide an electrical plant for the workhouse at a cost of £2,038.

Birkenhead.—The Town Council is to consider shortly a committee's recommendation that application be made for a provisional order authorising the Council to supply electricity for public and private purposes within the area comprising the districts of Bidston and Noctorum.

Bolton.—The report and balance-sheet dealing with the working of the Bolton Corporation's electricity department during the past financial year were brought forward for confirmation at a special meeting of the Town Council last week. Councillor Dr. Panton, as chairman of the Electricity Committee, took advantage of the occasion to refer briefly to the progress which the undertaking was making. He said that during the last 12 months they very largely increased their output, and their net profit had advanced from £917 to £1,205. This was not phenomenal, but it was fairly satisfactory, and represented a rate of 6¾ per cent. on the gross capital involved, consequently they were only 2¼ below the Corporation's premier money-earning department. Had they not been seriously handicapped by sinking and reserve fund charges, &c., which represented 2·88 on their gross capital, the amount paid to the rates would have been £2,000, as against £1,000. This was, he added, the first year the consumers had paid the total cost for making the electric current. In the first year every Board of Trade unit generated cost the borough nearly 9*d.*, whereas they were selling it at 5d. The second year the cost was 6d., and the Corporation still sold at 5d. In the third year the cost was 4·06, and they sold a fraction below, but during the past year the cost was slightly under 4d., and they had got a little over that amount. The year's consumption paid all the charges involved and £1,000 were handed over in relief of rates. Next year they would probably be in a position to hand over two or three thousand pounds. Dr. Panton added that they were spending something like £70,000 on the electricity undertaking during the coming year, and as this would not be immediately productive he hoped the Council would not expect too much from them. Before concluding the doctor warmly complimented the electrical engineer (Mr. Arthur Ellis) and the staff generally for the very efficient manner in which they discharged the duties. Alderman T. B. Tong complained of the high charges made by the department for electrical fittings, and mentioned a case where it cost £50 to light the ground floor of a house with electricity. His opinion was that the Corporation would do a bigger trade if they would revise the charges and place them on a more reasonable basis.—Councillor Dr. Panton, replying, said this was a matter which cut both ways. They were a trading department, and 90 per cent. of the electrically lighted houses in the town were wired by them, and he thought the usefulness of the station was being hampered by this fact. He did not wish to say anything disrespectful of the electric fittings department, for it was a very good one, and working well, but if there were four or five other firms similarly engaged in the town, it would be of immense service to the electricity department. As to the prices charged for fittings, he thought the Council would agree with him when he said it would be very unfair for the Electricity Committee to cut down such prices unduly, because if they did so they would be competing unfairly with other firms, and that with public money.—The report and balance-sheet were adopted.

Messrs. William Edge & Sons are having their works in Raphael Street lighted throughout with electricity. The order, which is placed with Messrs. Platt & Bleasdale, includes 350 to 400 16-C.P. lamps.

Bonchurch (I.O.W.).—The Parish Council has been considering an offer of the Electric Light Company to light 26 25-C.P. street lamps for £65 per annum. The Council decided to obtain further particulars and ascertain whether the light could be on by August 1st.

Bridgend.—At the last meeting of the District Council, it was reported that no tender had been received for the Council's provisional order, as advertised in the electrical papers, but a letter was read from the English Industrials Company, intimating that the Local Government Board had stated they would not grant a transfer in any town which would give the local authority any profit or premium, but they were now prepared to lay the necessary wires, &c., for the town and supply the Council with their lights at the actual cost price in lieu of the previous suggestion to give the Council a 5 per cent. upon the profits made by the company.—After some discussion it was decided to accept the terms as laid down in their letter.

Bristol.—Last week the Electrical Committee had before them a first proof of the accounts for the year. This showed that the twelvemonth was commenced with a trading balance of £5,000 carried forward; and although it was estimated that during the slack season—from March to September—there would be a loss of £5,000, it amounted to only £3,000. This is the more noteworthy, as the Committee have reduced the private and public lighting charges very considerably, representing, roughly, £2,500 on private lighting, and about £500 on public lighting. The year's business, as stated in a local paper, leaves a trading balance of £7,000, and it is proposed to put £2,000 to reserve (bringing the reserve account up to £5,000), £2,000 to depreciation, which practically opens that account, and to carry forward £3,000, which was found sufficient last year. The Committee do not anticipate, having regard to the reductions effected, and the heavy outlay and reduced revenue in the March to September term, that there will be any profit by the end of the year, but, as a matter of fact, they have so far made £2,000 net profit. The amount of capital to-day stands at £189,763, and the Committee has this year paid off £6,400 capital and £4,400 interest. The increased output is shown by the fact that whereas the number of units in 1898 was 910,888, for 1898-99 the figures are 1,362,786.

The Town Council this week considered the proposed agreement with the local wiring company as to a modified hire purchase wiring system, and referred the matter back for the Electrical Committee to consider whether they could undertake the wiring themselves.

Canterbury.—The public gas lighting contract terminates on June 25th, and the 170 incandescent electric lamps will then be ready.

Chester.—The Council has authorised the Electric Lighting Committee to have the necessary arc mains and distributing mains laid for supply of public and private lighting in Hough Green and Curzon Park, and the public lighting of Saltney main road to the city boundary (including 36 Jandus arc lamps), at an estimated cost of £3,500. Mr. B. C. Roberts last week said that the Council ought to congratulate themselves upon the fact that the electric light accounts were so satisfactory. The capital at their disposal was now £10,000 or £11,000, that being the balance of the £65,000 borrowed for the purpose of the electric light. That seemed to be a large sum to be in hand, but he might inform the members that that sum was already pledged to new works, and would, he hoped, be the means of bringing in a handsome income to the exchequer. The Committee had hoped that they should have been able this year to have relieved the rates to the extent of 1d. in the £, and they should have done that only they found, when they were about to make that handsome present to the city, that the rates had already been levied, so that such a thing would have been out of course and illegal. They had therefore wiped out the large amount which stood to preliminary expenses, and they had put £800 instead of £500 to reserve, and in this way they had got rid of their balance. Such was the satisfactory result of the second year of the Corporation having the electric light entirely in their own hands. The works were in a thoroughly satisfactory condition, and by putting a substantial sum to reserve they were always in a position to remedy any difficulties or damage to machinery. They hoped shortly to apply for a further loan.

Coventry.—In the quarter ended March 31st last the electric light rentals went up from £891 to £945, and the consumers from 112 to 135. The statement of the Electric Light Committee for the March quarters of 1898 and 1899 is:—1899: Electricity supplied during the quarter, 37,248 units; rentals for quarter, £945 19s. 5d.; number of consumers on March 31st, 135. 1898: Electricity supplied during the quarter, 35,090 units; rentals for quarter, £891 4s. 5d.; number of consumers on March 31st, 112.

The Dee.—There is a proposal to put down buoys for lighting the River Dee by electricity.

Durban.—A contemporary states that the Government electric light installation at Durban for the harbour is completed, and the light was switched on for the first time on April 27th.

Eastbourne.—At the last meeting of the Town Council the Electric Light Committee submitted a report recommending that Mr. W. C. C. Hawtayne be appointed consulting engineer to the Corporation at a retaining fee of 100 guineas for the first year, and

3 per cent. on all new works, which will include the preparation of a full report as to the carrying on of the electric light works, and advising the Corporation for the purpose of making application to the Local Government Board for power to borrow the amount agreed to be paid to the company, and that after the first year he be paid a retaining fee of 50 guineas and 3 per cent. on all new works, the engagement to be subject to six months' notice on either side and to terminate at the end of the current year in which the notice is given. On a division, the recommendation was adopted by 16 votes to 6.

Elland.—The Council is advised by the Electric Lighting Committee to apply for an electric lighting order. This is in consequence of the proposal of a company to put down electric lighting and tramway works.

Festiniog.—After considering a lengthy report by the surveyor on the gasworks and electrical supply, the District Council has decided to apply for an electric lighting provisional order.

Gateshead.—The Town Council last week considered a report from the Parliamentary Committee with reference to the electric lighting order which the Board of Trade had issued to the Electrical Power Distribution Company. The Board has deleted certain clauses, but it is proposed to petition the House of Commons Committee, in regard to the Bill, to get them inserted again.

Gravesend.—The Council notifies in the *London Gazette* its intention to transfer its provisional order to the Electric Supply Corporation, Limited.

Grays.—Last week the Council went into committee to consider the site for the electricity works.

Hackney.—We understand that the Electric Lighting Committee, which has for some months past been considering the question of sites for the electricity works, now has in view a convenient site contiguous to the River Lea, and will doubtless complete arrangements very shortly for its purchase. This is by no means a central point, so far as the proposed area of supply is concerned, but it is anticipated that the increased expense for feeders, &c., will be set off by a substantial reduction in the cost of land, as well as the convenience as regards water supply resulting from contiguity to the Lea. A compromise between the two conflicting parties on the Vestry will materially aid the Electric Lighting Committee in pushing forward the work with that expedition which is now necessary for its completion within a reasonable period. With so much work in the hands of manufacturers, it is not wise on the part of any municipality to delay the placing of contracts longer than is absolutely necessary. Now that Hackney is really moving with its electricity scheme, we anticipate that the time element will very largely influence the direction in which contracts are to be given.

Hampstead.—The Vestry's electric lighting system had on Lady Day last connections equal to 82,672 8-C.P. lamps. The consumers' accounts for the year amounted to £23,130 18s. 11d. According to a report presented by the Vestry clerk on Thursday last week, the capital expenditure of the system to Lady Day has been £125,410. The gross profit for the year was £13,014. After all deductions for interest, repayment of loans, bad debts, &c., had been made, the net profit stood at £8,339 15s. 6d. The gross profit was equal to a dividend of over 10¼ per cent. on the capital, and the net profit to one of over 6½ per cent.

Harrogate.—In commemoration of the eightieth birthday of Her Majesty the Queen, the new electric lights in the streets of Harrogate were lighted for the first time on Wednesday night last week. Eighteen lamps were lit in the principal streets in the centre of the town, each lamp being of 2,000 C.P.

Hull.—Last week Councillor Skinner, the chairman of the Electric Light Committee, presented his report, of which the following is an abstract, on the past year's work of the committee:—We commenced the year (the sixth) with 678 consumers taking 467,352 units in 12 months, at its close these had increased to 900 taking 749,690 units in 12 months, and this number will be largely added to during the next three or four months. After liberally maintaining the efficiency of the buildings and plant, providing the minor equipment for working the new station, renewing the Dagger Lane storage batteries, providing for a thorough overhauling of the engines at Dagger Lane by the makers, and meeting the total working expenses, excepting interest and sinking fund, the year's working has resulted in a reduction of the cost of production of a little over a farthing per unit. In 1897-98 the cost per unit sold was 2·78d.; in 1898-99 it has fallen to 2·51d. But for testing and other extraordinary charges in starting the new works the reduction in the expenses per unit would have been greater, and the profits would, of course, have been correspondingly increased. The financial results of the year are as follows:—The total income has been £16,332 18s. 9d. The expenses, exclusive of interest and sinking fund, have been £7,849 16s. 11d. Sinking fund, interest and depreciation of meters have absorbed a further sum of £4,822 15s. 9d. Thus the total expenses have amounted to £12,672 12s. 8d., and if this sum be deducted from the receipts there will be left a balance of £3 660 6s. 1d, which is the net profit on the year's working. This amount will be carried to the reserve fund, which, with this substantial addition, will then amount to £8,168 13s. It is proposed to make a reduction, as and from March 31st last, of ½d. per unit on all current sold for lighting purposes only. This proposed reduction in the Committee's charges, if adopted, would, on the basis of last year's working, involve a reduction of about £1,500 in the profits for the year, bringing them from £3,660 to £2,160. If the proposal submitted be adopted, the charges will then stand as follows:—Ordinary consumers for light, 5d. per unit; ordinary consumers for other purposes, 2½d. per unit. Large consumers, having more than 100 lamps fitted up, and charged on the Brighton system, 5½d. for first hour, and 2½d. afterwards. The demand for current has been continuously increasing throughout the year, owing not only to an increase in the number of consumers, but also to an increase in the average amount of current used by each consumer, which has risen during the year from 690 units to 780 units. So rapid indeed has been the increase in the demand (even before the station was formally opened) that had all consumers made a demand at the same time, the plant would have been taxed to its utmost capacity. During the 12 months under review, the equivalent of 17,000 lamps of 8-C.P. have been connected to the mains, this figure including 14 motors of various sizes. In consequence of this extraordinary demand the Committee were, in November last, compelled to refuse applications for current except on the condition that these applicants should not be attached to the mains until some time in February, or possibly the beginning of March. Foreseeing the inadequacy of the new station to meet the coming demands, a scheme for the extension of the Sculcoates Lane station, estimated to cost £32,000, was submitted to, and received the approval of, the Council, and power to borrow the money was granted by the Local Government Board. Tenders were accepted for the carrying out of this extension, and the work is now considerably advanced, and is expected to be ready for use in September, by which time it will be absolutely needed. The increasing demand also foreshadowed the necessity for putting down additional mains. Schemes for laying down several miles of new mains have also been sanctioned by the Committee, and the Local Government Board has sanctioned the borrowing of the money required. During the year, mains have been laid in nearly eight miles of streets, and others are still in progress.

Ilford.—The District Council will apply to the Local Government Board for sanction to borrow £4,300 for a site for electricity works.

Islington.—Last week the Vestry adopted the recommendation of the Electric Lighting Committee regarding the proposed extension of mains to Hornsey Rise and Newington Green districts for public and private supply, in accordance with the report of Mr. Gay, the electrical engineer. The total cost is £67,150.

Kettering.—The Lighting Committee has considered and deferred to another meeting a proposal to call in an expert to advise as to proceeding under the Council's provisional order. The Electric Power Distributing Company has submitted the terms upon which it would take over the order.

Leighton Buzzard.—The Public Works Committee recently recommended that Dr. Stevenson's communication in reference to the electric light lie on the table, as they did not consider that the time had arrived when the new illuminant could be adopted in the town.

London, E.C.—At a special meeting of the Court of Common Council on Monday, the Streets Committee brought up a report on the electric lighting of the City, but, before it was read or discussed, the City Solicitor, replying to questions, said that if any member of the Court happened to be a shareholder of the City of London Electric Lighting Company and voted on the matter he became liable to a severe penalty. So far as the latest return of shareholders indicated, there were then only three members of the Corporation holding shares—viz., Mr. Rowland Perrin (who had recently died), Sir George Faudel-Phillips, who was simply a trustee for others, and Mr. Foster McGeagh. Neither of the latter members was present. The report of the Streets Committee stated that they had had a conference with Sir David Salomons, the chairman, and the board of the Electric Lighting Company, and had invited their attention (1) to a reduction of the price of the electric light, (2) to the lighting of the minor streets, and (3) as to a basis of future purchase by the Corporation of the company's undertaking. They had since received a communication from the company in which they said they could not, in justice to their shareholders and in view of the obligations imposed upon them by the contracts and provisional orders, reduce the price of electric energy. The company had, it was pointed out, voluntarily introduced the sliding scale and had made a considerable reduction in the charges, and they were prepared to make further reductions when practicable. If it was the wish of the Corporation that the company should surrender their rights to light the minor streets, they would be prepared to do so on the understanding that if those streets were hereafter lighted by electricity the contract should be offered to them in the first place. As regarded the question of purchase, the directors would recommend the shareholders to sell their undertaking on terms which would yield a handsome profit to the Corporation, calculating it on the basis of the credit of the Corporation being able to borrow the purchase money at the rate of 2½ per cent. per annum. A later letter intimated that if the Corporation would withdraw their opposition and give all reasonable facilities for the supply of a continuous current, the company would reduce their price to 6d. per unit from January 1st next, and make further reductions whenever practicable. They were also prepared to make a very substantial alteration in the pressure. A communication was read from Sir Courtenay Boyle, secretary of the Board of Trade, asking to be favoured with the final views of the Corporation on the subject of the electric lighting of the City by Friday (to-day). The Committee recommended that the company be informed that although the Corporation was advised that the existing contracts were null and void, it did not desire to take advantage of the circumstance provided the company were prepared to come to satisfactory arrangements in regard to the supply of electricity to private consumers. Mr. Algar, chairman of the Committee, moved the adoption of their report. Mr. Turner proposed, as an amendment, "That, having regard to the opinion of counsel, Sir Courtenay Boyle and the company be informed that it is the intention of

the Corporation to treat the electric lighting contracts as null and void." Mr. Burnett, Mr. Clough, M.P., Mr. Judd, and other members contended that there had only been a technical breach of the contracts with the company by reason of a few members unwittingly investing their money in the company's shares—most of them after the contracts were concluded and in operation—and that it would be unworthy the prestige and dignity of the Corporation to take advantage of a paltry technicality of the kind. Mr. A. C. Morton, on the other hand, said that the contracts were obtained by improper influence and despicable means, and they ought to be vitiated for the honour, credit, and good name of the City of London. He hoped that the Board of Trade would throw open the City to competing companies. The City Solicitor, replying to questions, said if the existing contracts were null and void the Corporation could make fresh arrangements with the company, or the company could promote an Act of Parliament giving them relief from the breaches of the present contracts. He reminded the Court that it did not follow that the company would concur in the opinion of the counsel consulted by the Corporation that the contracts were null and void. They might go to litigation on the subject. Mr. Turner's amendment was lost by a large majority, and, after other amendments had been discussed and negatived, the report of the Streets Committee was adopted.

Nottingham.—Although the extension of the Corporation electric lighting station in Burton Street is now, from a structural standpoint, complete, it will probably be the end of September or the beginning of October before the new plant is running. The present capacity will be more than doubled.

Oldham.—Last week the following report was submitted to the Electric Light Committee by the superintendent, Mr. A. Andrew. The expenditure on capital account during the year has been as follows:—Supply station, buildings and plant, £4,492 12s. 2d.; street mains, £3,557 5s. 8d.; a total of £8,049 17s. 10d. The gross revenue for the year amounts to £6,804 2s. 6d., and the gross expenditure to £2,243 5s. 9d., the balance carried to the net revenue account being £3,560 16s. 9d. The interest on loans amounts to £1,396 13s. 11d., and sinking fund instalment to £1,279 10s. 4d., a total of £2,676 4s. 3d., the net profit for the year being £884 12s. 6d. The amount in reserve fund on March 25th was £4,275 5s. 9d. The amount of energy generated has been 589,633 units, of which 454,907 units have been sold, being increases over the previous year of 192,889 units and 132,704 units respectively. The number of lights supplied on March 25th last, equivalent to 8-C.P., was 28,471, being an increase during the year of 6,845. The number of consumers added has been 110, and additional meters fixed 120. The number of consumers on March 25th was 323, and the total number of meters fixed 380. The maximum demand was on February 24th, 1899, the load at the station being indicated at 542 kilowatts, as compared with 413 in the previous year. The greatest quantity supplied in 24 hours was on December 17th, 1898, being 3,198 units, against 2,307 last year. The supply mains have been extended 3,161 yards. The total length of mains laid on the March 25th last was 12,491 yards. The price charged for energy was reduced from March 25th, 1898, as follows:—To private consumers, ordinary rate, 4d. per unit; to the same for quantity used in excess of two hours' average maximum demand, 2d. per unit; public street lighting, 2½d. per unit. From September 25th large consumers have had the option of being charged either under the demand indicator system or according to the following fixed scale:—For the first 1,000 units consumed per quarter, 4d. per unit; for the second 1,000, 3½d.; third 1,000, 3d.; fourth 1,000, 2½d.; fifth 1,000, 2d.; all in excess of 5,000, 2d. During the year two additional engines and dynamos of 360 H.P. capacity each, and an additional steam boiler, have been fixed. The total engine horse-power is now raised to 1,800.

Oswestry.—A special meeting of the Town Council was held on Monday to consider a recommendation from the Watch Committee that the electric lighting company's undertaking be purchased, and that a committee be appointed to negotiate terms with the company, with power to arrange the price.

Portsmouth.—At a meeting of the Electric Lighting Committee of the Town Council, it was reported that the profits on the undertaking for the past year amounted to £2,500. It was decided to propose to appropriate about £1,500 to a reserve and sinking fund, thus making it up to 5 per cent. per annum on the capital outlay for the whole period since the commencement of the work, and to recommend to the Town Council that the balance, which, after leaving a small amount to cover possible bad debts, will be about £1,000, should be paid into the Urban fund, to go towards the relief of the rates.

Rothesay.—A Glasgow paper says that the contractors have made a good start with the electricity undertaking. Some of the cable has been laid and lamps are in position.

Shanklin.—The Lighting Committee asked the Board of Trade to modify certain sections of the provisional order in such a manner as to make it obligatory both upon the local authorities and the undertakers to submit all questions of difference which may arise to a sole arbitrator to be appointed by the Board of Trade, instead of a general arbitration as at present provided for in the existing draft provisional order. The Board had written stating that they would not make the suggested alteration.

Simla.—A Delhi paper says that the scheme for the lighting of Simla with electricity is being discussed, Mr. Crompton having recently been inspecting the Sutlej Valley with a view to the utilisation of water-power by turbines for this purpose. It seems that the cost would not be excessive, and the matter is likely to be taken in hand before long.

Sunderland.—The annual report *re* the Electric Light Works, shows that for the past year, after paying interest and sinking fund, there is a profit of £364. The number of lamps in use has increased to 25,617. The number of units sold has increased from 270,209 to 472,240. During last year 15 motors, aggregating 93 H.P., were added, making altogether 400 H.P. drawn from the Corporation mains. The past year was the first in which the undertaking showed a net profit after payment of the sinking fund and interest. The year's profit on the station—that is the sum available as dividend were the concern a private company—was £2,855, or 4⅘ per cent. on the capital outlay. The sinking fund and interest was £2,501, leaving a net balance of £364 to the credit of the Corporation. The average price obtained for current during the year was 3·78d. per unit to private consumers.

Tynemouth.—Last week the Local Government Board held an inquiry relative to an application of the Town Council for sanction to borrow £34,850 for purposes of electric lighting. The town clerk said there had been a prior application to borrow £1,850 for the purchase of land for a site, and the inquiry was held on June 10th, 1893. Sanction to borrow the sum had not yet been received, and the amount was now included in the present application. The details included £5,000 for building, £6,000 for three boilers and fittings, £1,000 for condensing plant, £7,000 for cables, and £2,000 for meters and services. An agreement was entered into in December last with the British Electric Traction Company, Limited, for the supply of energy to the present tramways from Prudhoe Street to Tynemouth, and an extension was in contemplation to Whitley, about three-quarters of a mile outside the borough.

Wallasey.—The District Council was yesterday asked to confirm a resolution of committee to obtain powers to borrow £18,500 for extending the generating station and providing additional plant to supply electricity for traction purposes.

Warley.—The District Council objects to the proposal of the Sowerby Bridge Council to apply for electric lighting powers within their gas area.

West Bromwich.—The question of the electric lighting is under the consideration of a committee of the Corporation, who are being assisted by a expert. Meanwhile the Midland Electric Corporation for Power Distribution, Limited, are making strenuous efforts to induce West Bromwich to accept the light from the company, and with this view the latter have submitted the following terms to the committee of the Corporation:—

For lighting purposes, 6d. per unit for the first 100 hours of supply per quarter, and 3d. per unit for subsequent hours of supply, with discounts of from 5 per cent. to 20 per cent. where the consumption is over 100,000 units per annum. For power purposes the rates are to be 3d. per unit for the first 78 hours of supply per quarter, and ·825d. per unit for subsequent hours of supply. The company offer the current to local authorities for public lighting at 1·6d. per unit.

Mr. G. L. Addenbrooke, the consulting engineer of the company, has also had an interview with the Mayor, Councillor S. Pitt, at which the latter suggested that the Midland Electric Corporation should submit a series of prices concerning all the alternative propositions they were prepared to make. The company, however, replied that this would be inconvenient and probably confusing, unless they knew the lines on which West Bromwich Corporation would prefer to negotiate, and instead wrote on February 24th last, asking for another interview. In the meantime, the Town Council authorised the Electric Committee to call in expert advice. Noting this, Mr. Addenbrooke wrote stating that if their consulting engineer would give them figures as to the prices at which West Bromwich could generate or sell current in the borough under the three heads of light, traction and power, and if he would corroborate his report by referring to results already obtained in similar towns, he (Mr. Addenbrooke) had confidence in stating that the Midland Electric Corporation would be prepared to supply at 10 per cent. under these figures where their figures are not already lower than this, and that they would further be prepared to agree to a set of discounts by which the cost would be still further reduced as the consumption grew. It is stated now, however, that the committee are convinced that they will be able to supply West Bromwich on quite as favourable terms as the Midland Electric Corporation can do it. Many of the members of the Council look at this question in conjunction with the probable taking over of the tramways, in which case they firmly believe that the two undertakings can be well worked together.

Winchester.—The Winchester Electric Light Company are making rapid progress with their business. The light is now being installed in the Guildhall, School of Art, public library, &c., as well as in many private residences and business establishments.

Windsor.—On the night of the Queen's birthday the arch on Castle Hill was illuminated by 1,000 electric lights, and the 1887 Jubilee statue, the Guildhall and various buildings were similarly decorated.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Accrington.—The Accrington Corporation Tramways Company have agreed to sell their undertaking to the British Electric Traction Company for £56,000, subject to certain conditions.

Barnsley.—The British Electric Traction Company, Limited, have intimated to the Town Council their intention of applying for a provisional order for the laying down of a light railway in Barnsley, and their intention to extend the same to Stairfoot and Worsbro', and the Corporation have decided that the application of the company named, or any other private company, shall be opposed. In view of this, Mr. John Carrington, solicitor, of Barnsley, on behalf of the British Electric Traction Company, Limited, has issued to the ratepayers a lengthy statement in pamphlet form, under the title of "Proposed Barnsley Tramways; Comments and Remarks thereon," showing reasons why the Council should approve the scheme.

Bath.—One of the companies which had given notice of intention to apply for an order under the Light Railways Act, is advertising its proposals in the usual form in the local press. The scheme aims at connecting the outlying districts with the central parts of the city by electric trams without actually touching upon the really busy thoroughfares any more than can be avoided.

Behr's "Lightning Express."—The joint committee of Liverpool and Manchester representatives who have been considering the scheme for establishing an electric express railway on the mono-rail principle between Manchester and Liverpool, have reported favourably, and declared that from an engineering and commercial point of view the project is a feasible one. On Wednesday a resolution was adopted setting forth that some such scheme would be of public advantage. The estimated cost of construction is a million and a half.

Brighton.—A deputation from the Corporation inspected the Sheffield electric trams, so far as completed, on Saturday last. It is stated that the gradients of the two towns are very similar.

Burton-on-Trent.—A Town Council deputation has inspected the Bradford electric trams. This is in connection with the proposal that Burton should have electric lighting and electric trams.

Cardiff.—The Tramways Committee last week decided to rescind the resolution giving the tramways company power to double certain sections of the tramline. The company had objected to several proposals in the draft agreement with the Corporation.

Dublin.—The connecting link of the tramway system between Castlewood Avenue and Harold's Cross line was opened on 23rd ult. for traffic. The cars now run from the junction with the Harolo's Cross line at Kenilworth Square direct to Ball's Bridge in connection with the Dublin and Dalkey electric line. The work on the Drumcondra line is also being pushed forward rapidly, and it is expected that in the course of a few weeks the line will be electrically equipped. In the meantime the service from the Pillar by means of horse cars is proving of the greatest convenience.

Eastbourne.—A special meeting of the Town Council was held last week to consider and determine as to a recommendation to apply, in November next, to the Light Railway Commissioners for an order, under the Light Railway Act, to authorise a scheme for electric tramways for Eastbourne under the auspices of the Corporation. The Electric Light Committee reported having had proposals before them from the British Electric Traction Company to the effect that the Corporation should construct tramway lines and lease the working of the same to the company for a period of 35 years, determinable at the end of 21 years, and at recurring periods of 10 years, the company to pay the Corporation 6 per cent. on the total outlay, and to take the current for motive power from the Corporation at a price to be agreed upon. The committee declined to entertain these proposals at present. The committee recommended that the proposed tramways should extend from Fort Road, along Seaside Road, and South Street, as far as the Town Hall, and that all other portions of the scheme, as first laid before the Council, relating to Upperton and Old Town, be abandoned. Deputations with petitions both against and in favour of the proposal—in principle or as to its application—were received and heard. In moving that application be made to the Light Railway Commissioners for an order to authorise the construction of the tramways, as recommended by the committee, Councillor Maude contended that the inconveniences and dangers arising from the tramways had been greatly exaggerated, and that if lines were introduced into any portion of the borough there would be a universal cry for their extension. The committee had had an approximate estimate of the cost for double lines, including motor cars, &c., and the expenditure involved would be about £13,000 per mile. After discussion, the motion for the adoption of the committee's recommendation, with an alteration in the route, was adopted by 17 to 10, but the town clerk pointed out that the resolution was not carried by the necessary two-thirds of the Council. In reply to a query: "Where are we now, sir?" The Mayor said: "You have not had the necessary majority, and, therefore, the matter must end."

Erdington.—A special meeting of the District Council met to consider what steps, if any, should be taken in reference to an application now being made for power to promote a light railway from Aston, through Erdington, to Sutton Coldfield. It was resolved to oppose the scheme.

Huddersfield.—The Holmfirth District Council is approaching the Huddersfield Corporation to know on what terms they will extend their tramlines to Holmfirth and Holmbridge.

Kingston.—The Corporation have prepared plans for an electric tramway to connect Kingston railway station with Surbiton railway station, as well as running through the principal streets of both towns, and it is also proposed to connect the line with the line of trams proposed to be laid by the London County Council, and to end at the borough boundary on Kingston Hill. The Surrey County Council is stated to have convened a conference of representatives of local authorities to ascertain how far electric tramways may be adopted throughout the county of Surrey.

Light Railways.—The *London Gazette* contains notices of the following applications to the Light Railway Commissioners for powers to construct light railways:—

Robertsbridge and Pevensey: promoted by the Earl of Ashburnham and others.

Rhondda Valley: promoted by the British Electric Traction Company.

Bridgwater, Langport, and Glastonbury: promoted by the Light Railways Development Company, Limited.

Aberdare: promoted by the British Electric Traction Company.

Wolverhampton and Bridgnorth: promoted by Mr. J. Heath, M.P., Mr. B. Melville, M.P., Sir H. S. King, M.P., Mr. J. T. Firbank, M.P., and others.

Peterborough and district: promoted by the British Electric Traction Company.

Blackpool and Garstang: promoted by the Blackpool and Garstang Electric Light Railway Company.

Darlington: promoted by the Imperial Tramways Company.

County of Middlesex: promoted by the Middlesex County Council and the Metropolitan Tramways and Omnibus Company.

Leighton Buzzard and Hitchin: promoted by Messrs. W. S. Cowper-Cooper, J. Waugh, H. J. Green, and others.

Gateshead and district: promoted by the Gateshead and District Tramways Company.

Worcester and district: promoted by Worcester Tramways, Limited.

South Staffordshire (Bilston, Willenhall, and Coseley): promoted by the British Electric Traction Company.

Maidstone and Faversham Junction: promoted by the Maidstone and Faversham Light Railway Company, Limited.

Ormskirk and Southport: promoted by Messrs. C. Birchall, T. O. Callender, W. Winnard, A. T. Wright, and others.

Leicester, Anstey, and Newtown Linford: promoted by the Railway Developments, Limited, of 34, Victoria Street, S.W.

Fleetwood and Morecambe: promoted by A. Bruce, T. D. Shield, and others.

Bere Alston and Calstock: Plymouth, Devonport, and South-Western Junction Railway Company.

Watford and district.

Finchley, Hendon, Edgware and district: by the Finchley District Electric Traction Company.

Southwold and Lowestoft: Southwold Railway Company.

Lastingham and Rosedale: Lastingham and Rosedale Railway and Estate Company.

Brackenhill: Yorkshire District Light Railway Syndicate.

Dartford district: International Communications, Limited.

Bromsgrove: G. G. Brodie, C. Steer, and others.

Barrowfield and district: J. J. Gittings, E. Horton, W. J. Kershaw, and others.

Highbridge, Wedmore, and Cheddar: Railway Developments, Limited.

Ryde and Sea View: E. Ironside Bax, G. Ellis, A. R. Davey, and others.

Liverpool.—When electing Mr. Petrie to a seat on the Liverpool Tramways Committee last week, the chairman of that Committee said they should remember that they might have very serious differences with Mr. Petrie's Committee concerning the supply of power for the tramways. Glasgow was getting its power at ¾d. per unit, while that Committee was paying 0·9d., or nearly four times as much. The Liverpool Electric Power Committee, however, were adopting a system diametrically opposite to that of Glasgow. They were making and supplying the electricity direct. In Glasgow it was to be supplied on the three-phase system, and transformed down by rotary transformers. There was in Glasgow only one electric power station of sufficient size. In Liverpool there were two or three; and while the Glasgow station could get fuel either by canal or railway, one station in Liverpool could only get fuel by the canal, and another by railway. Moreover, in Glasgow they used engines of 4,000 H.P., and of slow speed (75 revolutions a minute). The Glasgow system was based on the accumulated experience of this country, the United States, and the Continent. If Mr. Petrie would help to overcome the difficulty there was going to be on this matter, they would welcome him.

The question came up of extending electric lines to Garston, Woolton, Waterloo, and other suburban districts. The town clerk stated, with reference to the Overhead Railway, that electric lines in Waterloo and Seaforth were being laid by the District Councils of those places, and leased to the Overhead Railway Company, which proposed to use them as a feeder to its own line. If, when the electric tramlines were laid through Bootle and Litherland, the Corporation thought it worth while, they could apply for running powers over the Waterloo and Seaforth lines. There would be no difficulty in extending the lines to places beyond the boundary if the consent of the local authorities was obtained. On the proposition of the chairman, the manager was asked to report as to desirable extensions. The town clerk suggested that local authorities interested should be invited to confer with the Corporation, and this was agreed to.

A deputation attended to urge the views of the Estate Committee regarding the cost of street improvements, rendered urgent by the introduction of electric tramways.

Llandudno.—The promoters of the new light electric railway have communicated with the Electric Light Committee *re* scale of charges for the supply of current for the railway, stating that

they consider it fair and reasonable that the division of responsibility should be at the section boxes and not at the switchboard. Mr. A. H. Preece and Mr. Morton have reported on the subject, and the Council has approved the recommendation of the committee that no proposal for the supply of current other than at the switchboard be entertained. The committee has offered to supply energy at the following rate, viz.:—1½d. per unit for every unit up to 100,000 units; 1¼d. per unit for every unit over 100,000 up to 400,000; 1d. per unit for every unit over 400,000; the minimum supply in any one year not to be less than 350,000 units.

Middlesex.—A special meeting of the Hornsey District Council was held on Monday to consider the advisability of applying for an order to construct light railways along the Archway Road from Highgate to Whetstone in conjunction with the Finchley District Council. Since the notice of motion was given, the Middlesex County Council have come to terms with the North Metropolitan Tramways Company, by which the Council and the company will become promoters of a county scheme.—Mr. Sloper, chairman of the Highways Committee, moved the formal statutory resolutions.—The chairman (Mr. Cory-Wright) said they would be no better off there if the scheme was dropped. The County Council would make the line themselves and be the light railway authority. The resolutions were lost by a majority of two to one.

Newcastle-on-Tyne.—It is said that the Tramway Committee contemplates granting an extension of the tramway lease for two years, or until the new electric lines are ready, upon the present terms. The Newcastle *Leader* says that Prof. Kennedy sees no difficulty in combining the overhead trolley with a conduit system, connections to be made at suitable stopping places.

Perth (W.A.).—A Perth correspondent of the *Financial Times* telegraphs that the laying of the double track of the Perth Electric Tramways has been completed from Thomas Street to Milligan Street and from Pier Street to Bay Street. All the macadam paving has been completed, and the wood paving (Jarrah blocks), 13 feet wide, has been completed between Hill Street and Lord Street. The cars are ready, and the car house is complete, excepting a portion of the roof. The Babcock & Wilcox boilers have arrived, and are now being placed in position in the power house, and the artesian well has been sunk to a depth of 470 feet.

Peterborough.—The Town Council has under consideration correspondence from the British Electric Traction Company *re* the proposed light railways scheme.

Portobello to Musselburgh.—On Wednesday the Commissioners held an inquiry at Edinburgh into an application for a light railway to run on the road from Portobello to Musselburgh, and to be worked by electrical power. The scheme was opposed by the North British Railway Company, on the ground that it would abstract passenger traffic from their system, and was rejected by the Commissioners. The scheme was promoted by the Drake & Gorham Electric Power (Pioneer) Syndicate.

Portrush.—Last week a special meeting of the Urban Council was held for the purpose of hearing a statement from the chairman of directors of the Portrush, Giant's Causeway, and Bush Valley Railway and Tramway Company, in regard to the erection of iron pillars within the township in connection with the contemplated adoption by the company of the overhead system of electric traction. After hearing a statement from Dr. Traill (chairman of the company), in the course of which he quoted several clauses of Acts of Parliament under which, he contended, the tramway company were empowered to erect the poles in the town of Portrush, it was decided that as Dr. Traill had not come prepared to submit a proposal which might be accepted, the Council would adhere to their original resolution to have the poles removed.

Potteries.—That the new electric tramway system is exceedingly popular is evidenced by the complaints being made by the Stoke-on-Trent ladies that the cars are overcrowded. Of course, this will all be remedied as time goes on.

Shanghai.—The *Daily Mail* Montreal correspondent says that Sir Charles Ross, who recently made an offer on behalf of an American syndicate to purchase the municipal electric lighting works at Shanghai on condition of being granted the right to establish tramways there, is at present in China. Sir Charles, while passing through Montreal on his way to China two months ago, had a conference with some Montreal capitalists with regard to mining investments in British Columbia, and laid before them his scheme for electric tramways in Shanghai.

South Wales.—It is stated that there is very little doubt that Swansea borough tramways will be worked electrically before the present year expires. It is also represented that official intimation has been received that the Board of Trade has finally confirmed the Merthyr Light Railway order, which means the construction of an electric tramway from the centre of Merthyr to two of its chief suburban extremities, Dowlais and Cefn, Coedycymmer. It is further stated that the British Electric Traction Company are now applying for powers to construct a light railway from Aberdare to another populous adjunct of that great valley—that of Capcoch.

Sunderland.—The Tramways Committee recommends the Council to purchase 18 double-decked cars at £700 each, and eight single-decked cars at about £500 each, for service on the proposed electric routes. The Committee also instructed the electric engineer to ask for tenders for converting the tracks from horse to electric traction. Work on the Chester Road route will be commenced about August, and the whole of the system will be taken over and work commenced by January, 1900. The Committee has also discussed details with regard to poles, rosettes, and span wires.

Worcester.—The Pershore District Council has received a letter from the Worcester Tramway Company with reference to their proposal to make a light electric railway from Worcester to Redhill and Kempsey, and has approved of the principle of the proposal.

Kempsey Parish Council disapproves of a proposal of the Worcester City Tramway Company to construct a light railway to connect the city and Kempsey.

Wrexham.—At a meeting of the Council on 30th ult., the Lighting Committee reported that they had considered the report of Mr. Trentham and Mr. Peers, consulting electrical engineers, as to the introduction of electric lighting into the borough and the erection of a refuse destructor, and after some deliberation they recommended that the Council should approve of the appropriation and conversion of that portion of the Willow Brewery buildings and premises for electric installation works, but that the question of providing a refuse destructor be postponed for the present, reserving nevertheless the site adjacent to the electric works shown on the plans submitted as selected by the consulting engineers as best adapted for the erection of a refuse destructor. The committee also recommended that the Council engage Mr. Trentham and Mr. Peers as joint engineers for the works, and that they be instructed forthwith to prepare plans for estimates for the necessary works of supplying electricity in the compulsory area. These recommendations were agreed to. The Corporation seal was affixed to an agreement with the Drake & Gorham Electric Power and Traction Company, Limited, enabling the Corporation, after the expiration of 7, 14 or 21 years, from the date of confirmation of the Wrexham District Tramways provisional order, to acquire the undertaking.

Wycombe Valley.—It is proposed to obtain powers for the construction by a local company of an electric tramway through the picturesque Wycombe Valley, in Buckinghamshire.

TELEGRAPH AND TELEPHONE NOTES.

Cable Laying under Difficulties.—The *New York Herald* has received a telegram from Manila, which gives an account of a cable-laying party of Americans under Captain Tilley being fired upon and driven from the shore on the island of Negros. Captain Tilley, when last seen, was swimming feebly by the side of the mate of the cable ship. The latter was picked up by the launch of the steamer from which the party landed. The steamer lay far from the shore, but those on board of her saw some of the Malay seamen, who had landed with Captain Tilley, caught by the rebels and flogged, and then cut to pieces.

Colombo Telephone Service.—The conversion of the telephone system from earth to metallic return is progressing, but it is not likely to be completed for about six months.

French and English Trans-Atlantic Cables.—The Paris correspondent of the *Economist* points out that the long pending suit between the French Pouyer-Quertier and the English Anglo-American Trans-Atlantic Cable Companies has just come up again before the Rouen Appeal Court. It may be remembered that in 1880 the two companies, which had been worked in competition, entered into a pooling arrangement. The French Government subsequently, in 1886, intervened, and compelled the French company to withdraw from the contract, as being contrary to its Act of concession. The Anglo-American then brought an action against its former partner, claiming a sum of £240,000 which it had paid to the French company between 1880 and 1886. A first trial took place before the Paris Tribunal of Commerce, which, in 1888, condemned the Pouyer-Quertier Company to make restitution, and pay damages. In the meantime the French company had been converted into an American one, which, in 1894, obtained a reversal of the judgment by the Paris Appeal Court. The Anglo-American company took the case before the Court of Cassation, which quashed the judgment of the Paris Appeal Court, and ordered a new trial before the Rouen Appeal Court, which has now decided in favour of the Anglo-American, as was done by the Paris Tribunal of Commerce in the original action. The Court, however, admitted the right of the French company to certain set-offs, and appointed three experts to investigate the accounts and present a report within four months, the question of the costs to be in the meantime reserved.

The German Line to India.—From Berlin we receive news that an agreement has been arrived at between the Deutsche Bank and the Ottoman Bank for the continuation of the Anatolian railways. This continuation will probably admit of the extension of these railways to Baghdad, along the route which has been already surveyed, *vid* Yuzgat, Sivas, Diarbekr, and Mosul. The accompanying telegraph line will thus, on reaching Baghdad, be within some 250 miles of Koweit, which can be connected with a very short line to the Indian Government cables at Fao, thus cutting out the Indo-European Telegraph Company's lines, and rendering possible a reduction in the present high rates to India.

The "Monarch."—The cable ship *Monarch* is reported to have left Tobermory, Argyllshire, on Monday morning, *en route* for the small islands of Canna, Rum, Eigg and Muck, where cables are

to be laid connecting these islands with one another and with the mainland. The connection is to be made through the island of Skye, which is already in telegraphic communication with the mainland of Scotland.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.	Repaired.
Bonny-Cameroun	May 29th, 1899 ...	...
Lourenco Marques-Mozambique	May 26th, 1899 ...	...
Para-Maranham	April 10th, 1899 ...	...
Assab-Massaouah	May 23rd, 1899 ...	...
Amazon Company's cable—Cable beyond Garupa ...	June 11th, 1898 ...	...
LANDLINES.		
Communication between Mossamedes and all Inland Offices.	March 16th, 1899 ...	May 30th, 1899
Communication between Salonique and Monastir.	March 23rd, 1899 ...	...
Communication with Jérémié and Port de Paix (Hayti)	May 20th, 1899 ...	...
Communication with Swakopmund	May 18th, 1899 ...	...
Line between Antofagasta and Cochabambu (Bolivia)	May 9th, 1899 ...	...
Saigon-Bangkok ...	May 25th, 1899 ...	May 25th, 1899

The Telephone Question.—The Liverpool Chamber of Commerce has issued the text of a petition against Mr. Hanbury's Telephone Bill. It recites the provisions of the measure, and reviews generally the position and work of the National Telephone Company, and the views that have been expressed in regard to the Bill by various influential bodies. It prays that the existing system of the Telephone Company may be nationalised by acquisition on terms that are just and reasonable as between the nation and the company's shareholders, and that the whole system of telephones should then be worked as a department of the Post Office, or as a separate department.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barton-upon-Irwell.—June 6th. The Guardians want tenders for the wiring and fitting of their new infirmary buildings, Green Lane, Patricroft. Specifications, &c, from Mr. G. R. Peers, consulting engineer, 96, Deansgate, Manchester.

Battersea.—June 7th. The Vestry wants tenders for the supply of mains, water-tube boilers, steam dynamos and engines. See "Official Notices" April 14th.

Birkenhead.—June 9th. The Corporation wants tenders for one 225-kw. direct current high speed steam dynamo. See "Official Notices" May 19th.

Blackpool.—June 20th. The Corporation wants tenders for 6,000 tons of slack, 3,250 gallons of oil, and 138,000 carbons. See "Official Notices" this week.

Blackpool.—The Blackpool Masonic Hall, Limited, has invited tenders for the electric lighting preparations, electric bells and heating apparatus in the Masonic Hall, Adelaide Street. Particulars from the architect, Mr. J. A. Nuttall, Birley Street.

Canary Islands.—July 16th. Tenders are being invited until July 16th by the Spanish Post and Telegraph Authorities in Madrid for the concession for the establishment and working of a telephone system between Haria and Arrecife with three intermediate stations on the island of Lanzaroto, Canaries. Tenders to be sent to La Direccion General de Correos y Telegrafos, 10, Callede Carretas, Madrid, whence particulars may be obtained.

Doncaster.—June 7th. The Guardians want tenders for the electric lighting of the new workhouse. See "Official Notices" this week.

Dudley.—June 17th. The Electric Lighting Committee wants tenders for water-tube boilers, economiser, steam dynamos, balancers, switchboard, cables and street work, arc lamps, and travelling crane. See "Official Notices" May 19th.

France.—June 3rd. The French Post and Telegraph Authorities in Paris are inviting tenders until June 3rd for the supply of 16 lots of telegraphic apparatus. Particulars may be obtained from, and tenders are to be sent to, Le Sous Secretariat d'Etat des Postes et Telegraphes, Rue de Grenelle, 103, Paris.

Gloucester.—We understand that the Gloucester Railway Carriage and Waggon Company, Limited, are asking for tenders for fitting their works with electric apparatus, as the directors have decided on having electric transmission of power for the whole of the works.

Hackney.—June 13th. The Vestry invites tenders for trenching, troughing, cables, joint boxes, jointing and house services. See "Official Notices" May 5th.

Halifax.—The Watch Committee wants tenders for the wiring of the new Halifax Police Courts. See our "Official Notices" this week.

Huddersfield.—June 12th. The Corporation invite tenders for the electric equipment of their present steam tram service, also for works to be executed, plant and machinery to be supplied, as follows:—Contract No. 1.—(Section A) engines and appurtenances, overhead travelling crane; (B) direct current generators, switchboard, station lighting, motors, cables, trolley poles, controllers, &c.; (C) cableways, overhead construction, trucks, and car bodies. Contract No. 2.—(D) steam boilers and accessories; (E) condensers, valves, heaters, pumps, &c.; (F) economiser, elevator and conveyor. Any contractor may tender for the whole or part of the work included in Contracts Nos. 1 and 2. Specifications on application to the Borough Engineer, 1, Peel Street, Huddersfield.

London, W.C.—June 13th. Tenders are wanted for carrying out an electrical installation at Mr. Wyndham's new theatre, Charing Cross Road. See our "Official Notices" this week.

Manchester.—June 3rd. The Art Gallery Committee wants tenders for an electric installation at the City Art Gallery, Mosley Street. Particulars from the City Surveyor.

Sheffield.—June 5th. The Health Committee is inviting tenders for engines, electric lighting plant, pumps, shaftings, pulleys, and other engineering work required at the destructor. Particulars and specifications from the City Surveyor (Mr. Wikes), Town Hall, on payment of one guinea, returnable as usual.

Southampton.—June 5th. The Corporation wants tenders for motor cars and equipment, and the electrical equipment of lines. See "Official Notices" May 12th.

Spain.—June 8th. The Spanish Post and Telegraph Authorities in Madrid are inviting tenders until June 8th for the supply of 26,000 zinc cylinders for telegraph batteries. Particulars may be obtained from, and tenders are to be sent to, El Direccion General de Correos y Telegrafos, Calle Carretas 10, Madrid.

Spain.—June 25th. Tenders are being invited until June 25th by the municipal authorities of Alcala la Real (province of Jaen), for the concession for the electric lighting of the town during a period of three years. Particulars may be obtained from, and tenders to be sent to, El Secretario del Ayuntamiento de Alcala la Real (Jaen).

Teneriffe.—June 14th. Tenders are being invited until June 14th by the Spanish Ministry of Public Works in Madrid for the concession for the construction and working of an electric tramway between Santa Cruz de Teneriffe and San Cristobal de la Laguna, Teneriffe. Tenders to be sent to La Direccion General de Obras Publicas (Ministerio de Fomento), Madrid, whence particulars may also be obtained.

West Africa.—July 10th. The Compagnie de Mozambique, of 45, Rue do Alecrim, Lisbon, is inviting tenders until July 10th for the concession for the establishment and working of a central electric power station at Beira for lighting and power purposes during a period of 25 years. Particulars from, and tenders to, above.

York.—June 5th. The North-Eastern Railway want tenders for telegraph apparatus, wire and line stores. Particulars from Mr. Graves, Telegraph Department, York.

CLOSED.

Ealing.—The following is a list of tenders recently submitted to, and those accepted by, the District Council for the electricity extensions:—

CONTRACT No. 2.—BOILERS, SUPERHEATERS, &c.

		£	s.	d.
Messrs. The Stirling Boiler Company, Limited ..		2,490	0	0
" " "	(alternative tender)	2,968	0	0
" Robert Taylor & Sons	(accepted)	2,696	0	0
" Yates & Thom		2,800	0	0
(£300 of above amount was approximate.)				
" Edwin Danks, Limited		2,837	0	0

CONTRACT No. 3.—STEAM PIPES, &c.

		£	s.	d.
Messrs. John Spencer, Limited	(accepted)	2,427	15	0
" G. Wailes & Son		2,894	13	6
" C. S. Mallet & Co., Limited		2,976	6	0

CONTRACT No. 4.—SWITCHBOARD AND CONNECTIONS.

		£	s.	d.
Messrs. Cowans, Limited		1,045	0	0
" Warburg, Diamond & Co.		1,065	0	0
" Bertram Thomas		1,187	0	0
" Veritys, Limited		1,278	7	0
" Laing, Wharton & Down		1,286	0	0
" Prestwich & Burt		1,334	17	6
" Siemens Bros. & Co.		1,340	0	0
" Fowler, Lancaster & Co.		1,350	0	0
" Ferranti, Limited *(accepted)*		1,810	0	0
" Edison & Swan		1,934	12	0

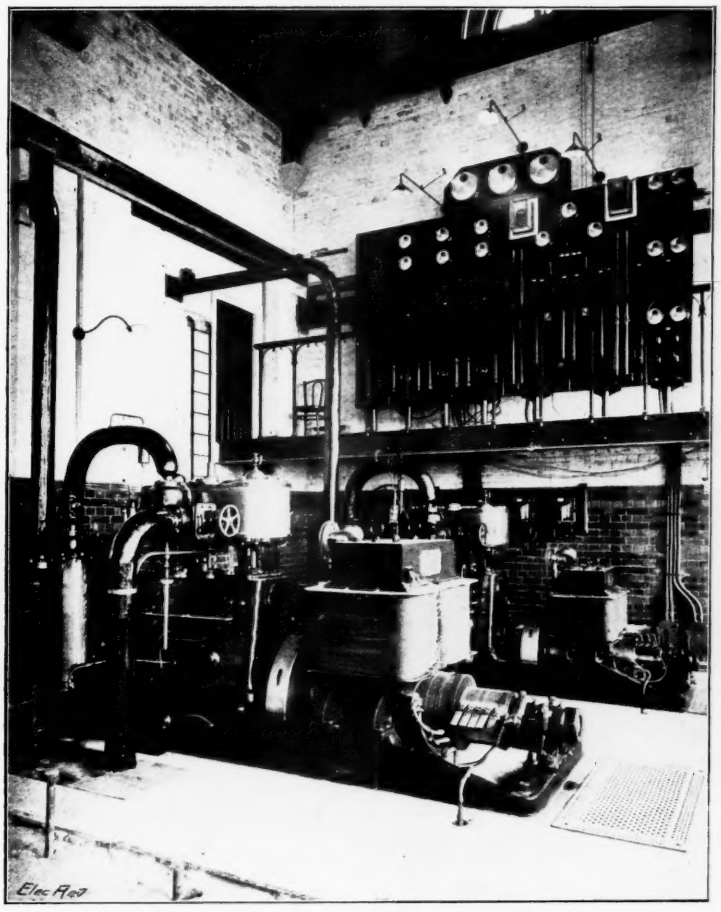
The tenders of Messrs. Laing, Wharton & Down and Messrs. Ferranti, Limited, were put forward for further consideration. Finally the tender of Messrs. Ferranti, Limited, was accepted. Messrs. Ferranti's tender includes connections and switch gear to each of the six existing alternators.

Hampstead.—Messrs. Davey, Paxman & Co., have secured the contract for new boilers, at the station for the extension which is proposed, with a tender amounting to £7,122.

(*Continued on page* 903.)

THE BARKING ELECTRICITY WORKS.

On the occasion of a recent visit to Barking we observed with feelings of dismay that to all appearances oil was superseding electricity for lighting the streets of that town. It seemed that Barking, instead of being off with the old love and on with the new, was doing the reverse, and had taken the horns by the bull. A closer acquaintance with the facts, however, served to disabuse our mind, for the secret of the apparent reversal of the order of things was that current had not yet been switched on for the public lighting, and oil lamps had been affixed to the pillars for temporary purposes only. In taking a leap direct from oil to electricity, Barking has but done as Winchester did last year. As a matter of fact, the introduction of electric lighting at Barking came about through the Barking Gas Company failing to come to reasonable terms with the Council for the lighting of the district, which has been done by means of oil lamps for some years.



General View.

In October, 1896, in consequence of a report prepared by Mr. Hawtayne, the Council applied for a provisional order, and resolved to put down a plant to deal with about 4,000 8-C.P. lamps for a commencement, including public lighting. When tenders were invited it was found that the work could be done at about £1,000 less than the estimates. Some extensions of mains were also decided upon at the same time, so that the total amount raised was £15,000. We need not enumerate all the various ways in which the gas interests sought to prevent the granting of a loan. Some indication is contained in the fact that the Local Government Board inquiry lasted for two days, owing to the strenuous opposition of the gas companies.

When looking up the records and finding the population of the town under 15,000, and bearing in mind that save for a few shops, factories, a chemical works, and a number of public houses, the residents are comprised mainly of the working classes, the man-in-the-street is to be pardoned if he wonders for a moment what prospect there is in store for municipal electricity works at a place like Barking. But we are given to understand that even before the public inauguration, when there had been nothing more than a preliminary switching on to private consumers, the load was very fair indeed. With all the street lamps in circuit, and the prospect of several large consumers, including the public offices and public houses, which, with their long hours, are exceptionally good customers of an electricity supply station anywhere, there seems to be a future of real, though, perhaps, gradual development at Barking. The small consumer also makes a very important customer, as has been found to be the case at Brighton, and other places, and every opportunity is to be taken to cultivate him.

Then, again, a source of business of great moment will be the Beckton-Barking electric trolley light railway, $1\frac{3}{4}$ miles long. It is stated that this is the only scheme which has been granted under the Light Railways Act to a local authority. The Board of Trade have sanctioned the expenditure of some £34,000 in connection with it. Mr. Hawtayne has the specifications practically ready, and the scheme will be proceeded with with little delay.

The Barking Council have since also applied for powers under the Tramways Act, and have the approval of the Board of Trade to a very large system of tramways, extending from Creeksmouth on the south up to the Ilford boundary on the north, where they will join up to the proposed Ilford tramways, which have also received the Board of Trade sanction, and on the west, with the East Ham Urban District Council's tramway scheme. Mr. Hawtayne has the tramways for Barking and Ilford in hand at the present time.

At Creeksmouth are situated Messrs. Law's Chemical Manure Works, and several other large works, which have jointly guaranteed an annual consumption of electricity to the amount of £350 for seven years, to induce the Barking Council to lay a large main down to them. This it has been decided to do, and motor generators will shortly be put in. The Council at their last meeting decided also to apply to the Local Government Board for a further loan of £18,000 to meet the extensions proposed to be carried out.

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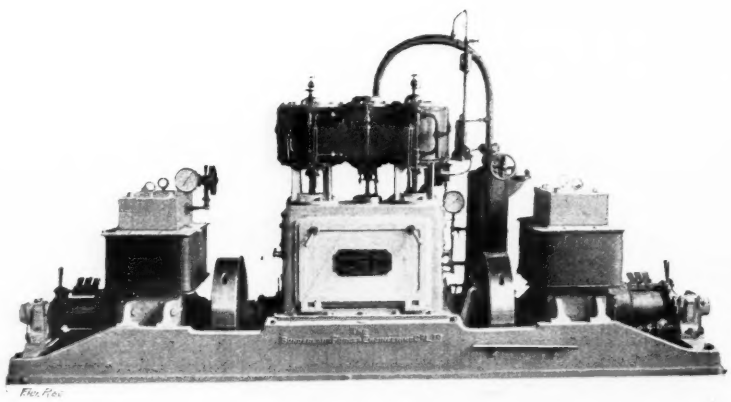
The generating station is certainly in a very congenial atmosphere, being next door to the mortuary, a circumstance serving to remind those engaged at the station of electric shock sheets, and so forth. The fire station, public offices, and public baths are also situated on the same site; in fact, the exhaust steam from the electricity works' boilers is to be utilised for heating the water in the baths.

The system is a three-wire continuous current with 460 volts across the outers.

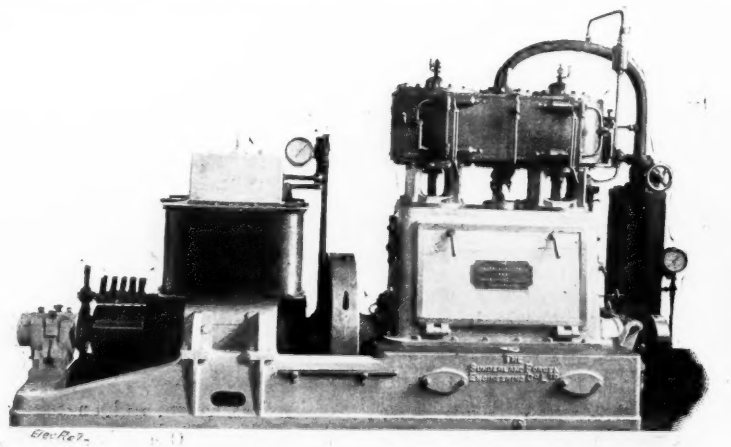
As to the electrical equipment of the works, the plant with which supply commenced in May was only of a total capacity of 120 kw., plus a battery of accumulators, but owing to the satisfactory demand for current another 80-kw. set is on order for the lighting, and space has been left in the station for two electric railway sets, each being something like 100-kw. capacity. The Sunderland Forge and Engineering Company have been responsible for the entire equipment of the station.



DOUBLE ENDED SET. 20-KW. DYNAMOS.

There are two boilers of Messrs. Babcock & Wilcox make, each having 1,098 square feet heating surface, 83 square feet grate surface, working pressure 160 lbs. per square inch, and each capable of evaporating 3,000 lbs. of water per hour. The two pumps for boiler feed service are by the Worthington Pumping Engine Company, and are capable of delivering 600 gallons of water per hour. There is also a Green's patent fuel economiser, consisting of 72 tubes 9 feet long. The scrapers of this machine are driven by a "Pallion" eight-pole open type motor.

There are two steam generating plants, as will be seen from our view of the station interior, one of 80 kw. output and the other a double ended plant, each dynamo capable of developing 20 kw. The double-ender is somewhat hidden by the larger set in our photograph, so we give a separate illustration of it. The engines in both cases are of the Sunderland Forge Company's improved enclosed self-lubricating compound double-acting central valve type, running at a speed of 450 and 500 revolutions per minute respectively, with a steam pressure of 160 lbs. per square inch. The dynamos are shunt wound, and mounted on the same bedplate as the engine. The armatures are of the slotted drum type, and in the case of the 80 kw. plant the end connections consist of copper spirals. The commutators are built up of drawn copper segments, and each spoke is dovetailed, sweated and riveted into its segment. The field coils are wound on metal spools, and have a liberal amount of wire upon them, the temperature of the coils, after the official test, not having risen any appreciable amount. The bearings of each machine, one to each dynamo, are large in diameter and about four times the diameter of the shaft in length. They are of the self-oiling type, being automatically lubricated by rings revolving slowly on the shaft, the lower portion of each ring dipping into a reservoir of oil in the usual way.



80-KW. GENERATING SET.

A well-arranged battery room contains two sets of Chloride "R" type cells, each set being composed of 127 cells. Each cell has a capacity of 250 ampere-hours, and is capable of discharging at 140 amperes for one hour with less than 10 per cent. fall of potential. The cells are contained in glass boxes resting on wooden trays supported on glass insulators. All connections on the cells are of lead, and are burned on. No copper or gun-metal connections are used. The cells are suitably arranged on pitch pine stands, to allow of easy inspection and access to each individual cell.

These batteries are to be used as a standby or for balancing purposes.

The switchboard, the position of which can be seen from the photograph, consists, as at present constructed by Messrs. Laing, Wharton & Dowr, of seven vertical panels and one cross panel. Each of these is mounted upon a "Whardown" cast-iron foot, with special insulating clamp providing secondary insulation for the whole of the switch gear. The boards are held perfectly upright by stay rods, also with secondary insulation. The panels are arranged as follows, commencing from the left hand side, facing the board:—

No. 1. A spare dynamo panel, fitted for an 80-kilowatt dynamo.

No. 2. An 80-kilowatt dynamo panel, consisting of a dynamo voltmeter, dynamo amperemeter, a minimum automatic switch, a double-pole main switch, a double-pole fuse, and a shunt resistance carried at the back of the board with a handle in front.

Nos. 3 and 4 panels are fitted for 20-kilowatt dynamos at half the main voltage, and have a similar equipment to No. 2 panel, saving that the double-pole switches are two-way, enabling either dynamo to charge either half battery, or be connected to either leg of the three-wire system.

Nos. 5 and 6 are the battery panels, and are connected to either leg of the three-wire system, and carry on them each a 31-way charge and discharge regulator, a centre zero ammeter, two-way charging switches, specially constructed battery meters registering the charge and the discharge current, and between the boards is a voltmeter, coupled to a four-way switch.

No. 7 panel is the feeder panel, consisting of three double-pole feeder switches and six amperemeters, dealing with each leg of the three feeders.

The cross panel at the top carries a main voltmeter reading the voltage on the outer wires, and two voltmeters reading respectively the voltage on each of the legs of the three-wire system.

The main wattmeters measuring the outputs of the various dynamos are carried on a special panel below the switchboard

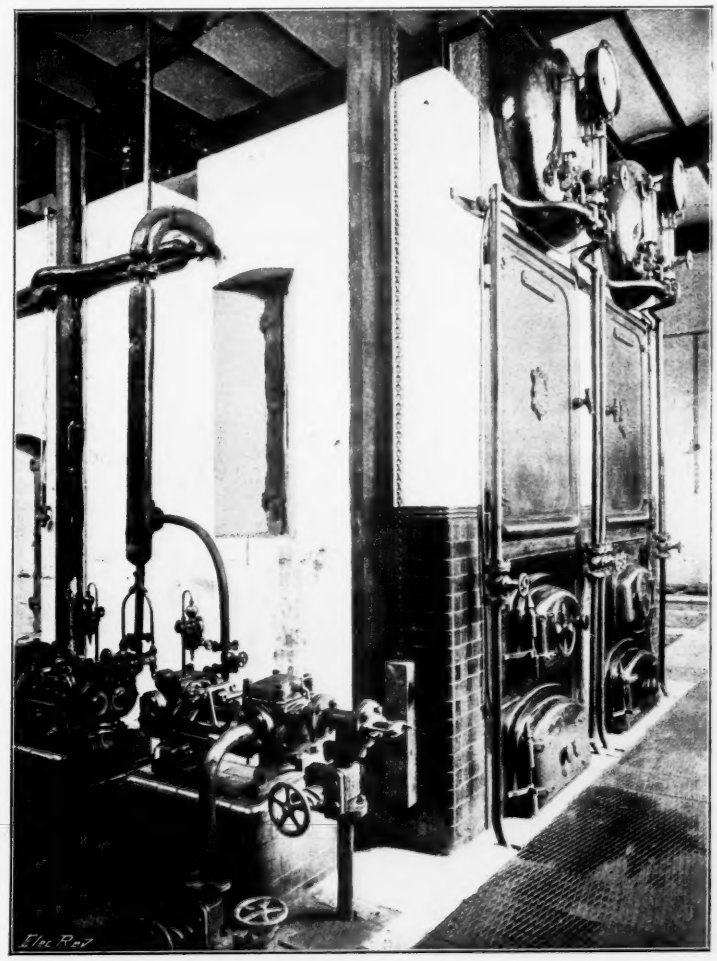
gallery, while on the board itself there are two Thomson-Houston feeder wattmeters mounted on white marble.

Room has been left to the right of the switchboard for the necessary panels for use when the proposed light railway gets to work.

The street lighting is effected by means of 14 Crompton-Pochin arc lamps of 2,000 C.P., also about 365 standards for electric incandescent lighting, each lantern having two lamps with Reason reflectors of a special design. The arcs are run two in series across the outers with a line resistance. Each of the standards has two 10-C.P. incandescents for lighting when the arcs are not required.

The cable work has been carried out by Messrs. Callender's Cable and Construction Company, all being laid on the Callender-Webber drawing in system.

The mains have been laid on the three-wire low pressure system, with a pressure of 460 volts between the outers. In the most important streets five-way conduits have been used, and in the by-streets three-way conduits. Into these conduits are drawn feeders and distributors. At present there are two main feeders, each consisting of ·2 square inch cone vulcanised bitumen cables. No. 1 feeder runs from the generating station (behind the public offices) to the corner of Axe Street and the Broadway, and No. 2 feeder runs from the generating station to a point in East Street, just outside the London, Tilbury and Southend railway station. The total length of feeder cables is 840 yards. The distributors consist of vulcanised bitumen single cables drawn into the Callender - Webber cases. Two sizes of distributing mains are used, being respectively $\frac{1}{4}$, $\frac{1}{16}$, $\frac{1}{8}$, and $\frac{1}{16}$, $\frac{1}{32}$, $\frac{1}{16}$ from the nearest point of the network to the generating station, three cables ·25 square inch in section are drawn in, connecting the network to the station. The total length of three-wire distributing mains laid up to the present is 9,500 yards, two feeder boxes, and seven network boxes of Callender's standard type for three-wire work, have been fixed at suitable points.



BARKING: BOILERS AND FEED PUMPS.

In addition to the mains for private lighting, provision has been made for lighting the whole area by arc and incandescent lamps. In the compulsory area this has been done by means of tappings of the distributing mains, consisting of vulcanised bitumen twin cable, lead covered and armoured. In the outside area twin cables have been laid for this purpose of ·028 square inch and ·008 square inch sectional area as occasion demanded. These cables are insulated with a dielectric of bitumenised fibre lead covered, protected with an armouring of two steel tapes and yarned overall. The whole of the excavation, conduit laying, cable laying, and lamp connection work has been carried out for Messrs. Callender's under the general supervision of Mr. F. E. Proctor, and executed on the spot by Mr. J. H. Preedy.

The resident engineer at the Barking electricity works is Mr. E. E. Hoadley, who came from the Worcester Corporation electricity works in December last year, and took up his position there at once so as to supervise the construction under the controlling hand of Mr. W. C. C. Hawtayne, who has acted as consulting engineer. Mr. Williams is assistant engineer.

ST. ANTHONY'S FALLS WATER-POWER PLANT.

AN interesting application of water-power is at St. Anthony's Falls, the plant furnishing power for the street railway companies of Minneapolis and St. Paul.

The site of the power house is located in Minneapolis, just below the great St. Anthony's Falls of the Mississippi, where there is a long stretch of rapids. The power company has the right for the entire width of the river at this place, but great care has to be taken not to interfere with the water rights of companies located above this plant, for if too much water were held back by the dams of the St. Anthony Company, the head above would be considerably diminished in a manner which will be explained later.

The power house of the company is located at the end of the main dam, on the north side of the river, and in reality forms a portion of the dam. The foundations are all built of cut granite, and the walls are of hollow tiling with sandstone trimmings. A steel frame, as shown in the interior view of the power house, supplements the wall and supports the roof, which is covered with slate. This illustration gives a general interior view of the station, showing the generators which are already installed.

The station is 250 feet long and 80 feet wide, outside measurement, and there is accommodation for 10 700-kw. units, directly coupled to horizontal water-wheels. The height of the building from floor to ridge of roof is 45 feet. Ample room is provided, as will be seen in the illustrations, for the installation of engines if it is found necessary to use them at times of low water, or when the plant is increased.

The station is also provided with an electric travelling crane, capable of handling any of the machinery in the station.

The retaining wall of the dam extends along the north

shore 740 feet from the power station to a point a short distance beyond, where the wing and head dam form an angle. This wall had to be built for the protection of the bank, and is constructed entirely of cut granite.

The main cross wall starts from the west bank of the river, and runs directly across for a distance of 500 feet. This is the length of the wall proper, and does not include gates or waste ways. It then branches off at an angle, and runs down stream nearly parallel to the east bank for 370 feet to the upper end of the large waste way, close to the power station. Between the waste way and the power house the wall is continued, but at an increased height. All of the construction is of the best cut granite, laid in cement.

As before stated, the power house forms a portion of the dam. There is a rack placed at the fore bay side of the power house, extending its full length, and the water, after passing through this, enters the wheel chamber and flows from the draught tubes into an arched tail race underneath the power house.

In addition to the main wheel chamber, there is another small wheel chamber at the north end of the building, used for the purpose of driving two exciters.

The head is a maximum of 22 feet and a minimum of 16, with an average of 20. In the interior of the power house the wheel chamber is faced for its entire length with glazed brick.

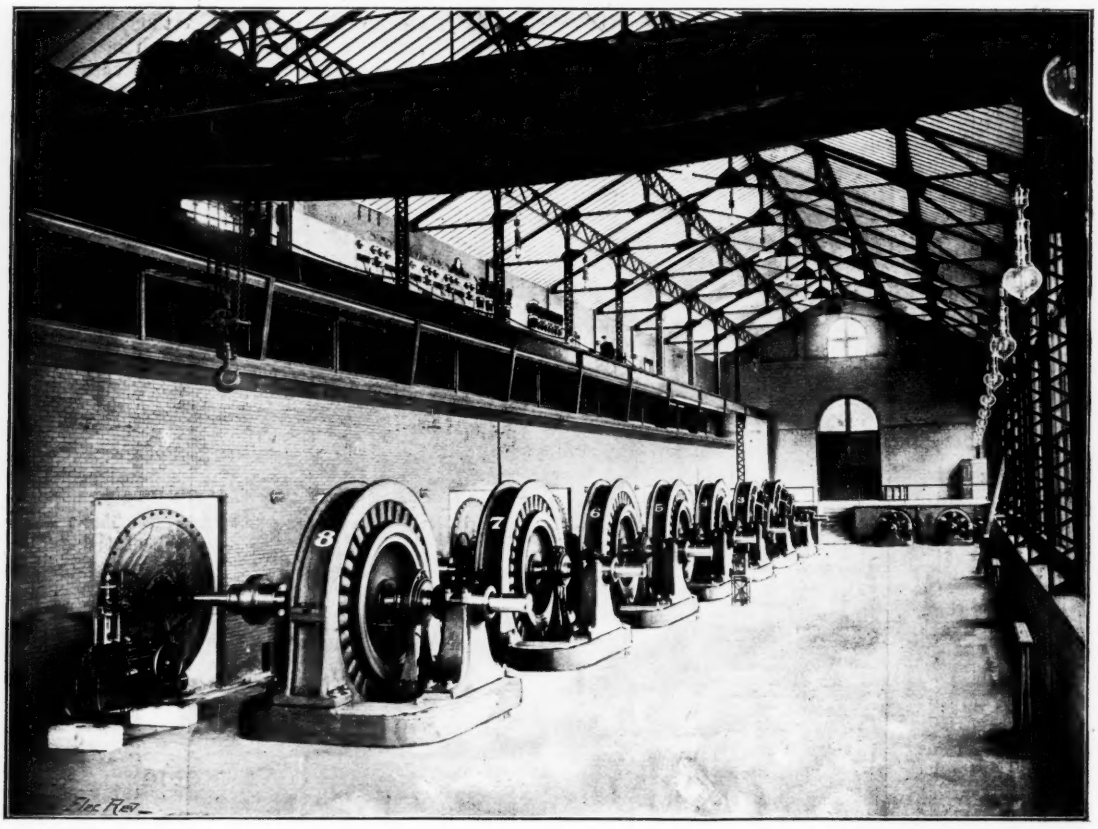
The complete water-wheel equipments for this plant were furnished by the Stillwell-Bierce and Smith-Vaile Company, and are of the well-known Victor type. To each 700 kw. unit there are two pairs of 42-inch horizontal wheels, giving a total of four 42-inch wheels directly connected with each generator shaft. These wheels are designed and guaranteed to develop 1,000 H.P. per set, or 250 H.P. each.

This method of installing wheels is an innovation in low head work, and forms an exceedingly compact and efficient unit. The shafts, with couplings attached, can be seen in the illustration of the power house projecting through the wheel chamber wall.

In addition to the wheels just described there are two sets in the wheel chamber at the east end of the house, which were manufactured and installed by the D. S. Morgan Water-Wheel Company. These wheels are for the purpose of operating generators for furnishing exciting current to all the three-phase generators in the station.

The governors were furnished by the Lombard Water-Wheel Governor Company. The governor is very well shown in the subjoined illustration, and is driven by a belt connected to a small pulley on the generator shaft. The excellent result given by these governors in other installations leaves no question as to their satisfactory operation in this plant. Each governor operates the gates for each full set of four wheels.

The electrical apparatus installed was manufactured by the General Electric Company. In the main station there are at present installed five 700-kw. three-phase generators, having 32 poles, and operating at a speed of 130 revolutions, giving a frequency of about 35.



INTERIOR OF ST. ANTHONY'S POWER HOUSE.

The base frame is so constructed that the field frame can be moved parallel with the shaft for the purpose of cleaning the armature or for repairs. The approximate weight of the armature is 25,000 lbs., and the complete weight of each machine about 84,000 lbs.

In addition to these machines, there are two direct current 700-kw. generators, having eight poles, and running at a speed of 130 revolutions per minute. These machines are wound for a pressure of 575 volts at no load, and over-compounded to a voltage of 600 volts at full load. They feed the 500-volt circuit direct from the power station, through five 500,000 C.M. cables.

The armature is of the well-known ironclad type, and is ventilated by means of ducts in the armature .4 inch in width. The armature windings on these machines consists of copper bars laid in the slots, the winding being of the type known as the "barrel."

(To be continued.)

CONTRACTS CLOSED.

(*Continued from page* 898.)

Liverpool.—The Docks and Harbour Board have given the contract for an electric lighting installation at certain portions of the Birkenhead Foreign Animals Wharf to the Brush Electrical Engineering Company.

Manchester.—The contract for the lighting of the extensions to the Corporation electricity works, Dickinson Street, has been given to Mr. G. A. Steinthal. The installation will consist of 14 enclosed arc lamps, two inverted arc lamps for the drawing office, 60 incandescent lamps, and 30 wall plugs.

Sheffield.—Last week the City Council gave the order to Messrs. Ferranti for the 1,000 kw. steam alternator at £9,500. The Electric Light Committee previously held back their recommendation.

FORTHCOMING EVENTS.

Wednesday, June 7th (also 8th and 9th).—Institution of Civil Engineers. Engineering Conference at Great George Street, S.W.

Friday, June 9th.—At 6.30 p.m. The Institution of Junior Engineers. Visit to the Bankside Works of the City of London Electric Lighting Company.

Wednesday, June 14th (also 15th, 16th, and 17th). Convention of the Municipal Electrical Association at Bristol.

Röntgen Society.—Through a printer's error in the announcement sent to us, the meeting of this Society was last week given as June 30th instead of May 30th. The meeting was held on Tuesday last.

NOTES.

Personal.—The sub-editing of the Electrical Review has for just 10 years been in the hands of Mr. H. Scholey, who to-day severs his connection with this journal to take up a position as the London and South of England representative of Messrs. Mather & Platt, Limited, to whom we offer our congratulations on the choice of a gentleman, who, we are sure, will right worthily uphold the firm's world-wide reputation. Mr. Scholey has performed yeoman service in the cause of the Review, and we gratefully and readily acknowledge our indebtedness to the able manner in which he has carried out his manifold duties both in the editorial sanctum and amongst all sorts and conditions of men throughout the United Kingdom. In cordially wishing Mr. Scholey every success in his new venture, we feel that we are but echoing the sentiments of all those to whom he has made himself known, and although we cannot hide the regret which the parting causes us, the severance has been brought about under such exceptionally good feeling on either side, that we trust our loss will be Mr. Scholey's gain. If, as has been happily said, Mr. Scholey makes as many friends in the future as he has in the past, there will be no one left of whom he can make an enemy.

The Article Club Exhibition.—In response to an invitation from the Article Club, we paid a visit to the Crystal Palace on Tuesday last, when the Duke and Duchess of Connaught formally opened the Article Club Exhibition. No doubt this ceremony was of considerable interest to the promoters, but our business there was, we thought, a little more serious than to attend a formal inauguration. We heard that some of the exhibits were interesting, but they were guarded too well to be inspected. The opening ceremonies of exhibitions have been frequently bungled, but we have been seldom invited to functions where less regard was paid to the convenience of journalists than at the Palace. If we had been told previously that the exhibits would not be on view until a certain hour, we could have made the necessary arrangements to be present later; as it is, we were subjected to great loss of time, and we consider we have a serious complaint to urge against the responsible officials.

The Société Internationale des Electriciens.—The usual monthly sitting of the Société des Electriciens was held on May 3rd, M. Violle, the new President, elected at the last meeting, being in the chair. After the matters in hand had been considered, M. J. Guillaume gave an account of the excursion to Switzerland made by the pupils of the Higher School of Electricity. He enumerated the various works visited, giving a brief description of each. Amongst the water-power installations we may mention the works at Val-de-Travers, Vevey-Montreux, Zurich, Dorenberg, Chèvres, Berne, Rathausen and Rheinfelden. Amongst continuous current distributions we may mention the Val-de-Travers and Combe-Garrot works. Visits were also paid to distributions by simple alternating, diphased, and triphased currents. The simple alternating current distributions were effected from the Dorenberg works at Lucerne, and from Neuchâtel. The stations using diphased currents were those of Chèvres, Olten-Aarbourg and Rathausen. Those using triphased currents were the stations of Neuchâtel, Schwitz, Wynau and Rheinfelden. The pupils of the Higher School also visited electrical traction installations at Vevey-Montreux and Lausanne, and the workshops of Brown-Boveri and Oerlikon. M. J. Guillaume gave descriptions of all these installations, and showed a great number of illustrations. At the end of the sitting, M. de Raveau made some observations on the variation of the resistance of metals with the temperature.

Electrical Cabs.—The facts of the case regarding the electrical cab accidents to which we referred last week are given in the following letter, written to the Press by Mr. W. C. Bersey, managing director of the London Electrical Cab Company, Limited:—

My attention has been called to some reports in the daily papers with reference to the starting of our electrical cabs on Wednesday, and I shall be glad if you will allow me to correct the information there given. None of our cabs were in Farringdon Road on Wednesday. The procession of nearly 70 vehicles passed down Fleet Street and up Ludgate Hill, and then *vid* St. Paul's, Newgate Street, and Oxford Street, to Kensington. In the reports it is stated that there were several passengers in the cabs, and that several accidents occurred. Both of these statements are absolutely without foundation, as there were no passengers in the cabs whatever, and the only accident which happened to the whole of the vehicles during the run was that some slight trouble was caused through one of the rubber tyres coming out of the rim of the wheel. It is also incorrect to state that some of the cabs had to return to the yard, as every one of the vehicles in the procession covered the whole route of about 18 to 20 miles. It is unfortunate that such unfounded reports reach the daily papers, and I am sure you will in fairness give publicity to this reply in your columns.

The Potteries Tramways.—We omitted to mention in our description of this system that Mr. W. Parrish Pearsall was engineer in charge of the overhead construction work carried out by Messrs. Blackwell. The Brush Company's contract was carried out under their superintending engineer, Mr. R. A. Dawbarn, their resident engineer being Mr. S. A. Mahood, and his assistants Messrs. King, Miller and Saner. The British Electric Traction Company's staff consisted of Mr. Angus, assisted by Messrs. Clough and Browning. The consulting engineer on the contract was Mr. Stephen Sellon.

The British Association Meeting.—Arrangements for the visit of the British Association to Dover this year are making good progress. The committees, according to the *Times*, are actively at work, and in response to the appeal of the Hospitality Committees over £1,500 has already been subscribed. In connection with the visit an instructive address was delivered last week by Sir John Evans on the Association's objects. The president of the Dover meeting will be Prof. Michael Foster, and the presidents of the various sections are to be:—Mathematical and physical science, Prof. J. H. Poynting; chemistry, Mr. Horace T. Brown; geology, Sir Archibald Geikie; zoology, Mr. Adam Sedgwick; geography, Sir John Murray; economical science, Mr. Henry Higgs; mechanical science, Sir William White; anthropology, Mr. C. H. Read; physiology, Mr. J. N. Langley; botany, Sir George King. Sir John Evans stated that there will be an exchange of visits between the British Association and the French Association holding its annual assembly at Boulogne. The Belgian Geological Society will visit Dover during the meeting.

The Utilisation of the Kerka Falls in Dalmatia.—A few days ago a contract was concluded at Trieste between the Societa Elettrochimica Veneziana and the firm of Antonio Tupuk & Son, of Sebenico, for the supply of 1,800 electrical H.P. for the period of 20 years at the rate of 100 francs per H.P. per year. This firm owns part of the celebrated Kerka Falls in Dalmatia, a small portion of which has already been utilised for the electric lighting of Sebenico, and for a small establishment for the manufacture of carburet of calcium (the first in Austria) with Siemens & Halske furnaces. The financial matters relating to the agreement were conducted by the bankers, Sig. Guilio Levi, of Trieste. In accordance with this agreement, Messrs. Tupuk will establish a new central station for three distributions of 1,000 H.P. for supplying the required energy to the Electro-chemical Society. Others of equal power will be established as fresh orders for energy arrive, as there is an immense power available. These orders will certainly flow in, as no other water-power in Europe is under such excellent conditions as these falls of Kerka, which are upon the sea. At a few hundred metres from the new station, and in a situation easily accessible to ships, the laboratory of the electrical furnaces of the Societa Elettrochimica Veneziana will be established; the triphased alternating current from the central station will here be transformed by means of transformers of a power of 250 kilowatts to the tension of 45 volts required for the furnaces. The complete installation will begin to work at the commencement of 1901. The arrangement of details, and the superintendence of the work at the central station are entrusted to Guiseppe Sartori, engineer and professor of electro-technics at Trieste, who will elaborate the first plans, as far as possible, for the most advantageous utilisation of the falls.

Amalgamation of German Electrical Interests.—The Bank fuer Electrische Industrie and the Electricitaets-Gesellschaft Felix Singer & Co. Actien-Gesellschaft, both of Berlin, and the Helios Electricitaets-Actien-Gesellschaft, of Cologne, with its financial company, the Gesellschaft fuer Electricitaets-Anlagen, are to be amalgamated. The Helios Company will raise its capital from 10,000,000 to 16,000,000 marks (£500,000 to £800,000), making it equal to the share capital of the Gesellschaft fuer Electricitaets-Anlagen, while the Bank fuer Electrische Industrie and the Singer Company will go into liquidation. As a result of this combination, or absorption, of interests, the Helios Company, which has hitherto been mainly occupied with the manufacture of electric lighting plant, will embark upon the construction and installation of material for electric traction. It is understood that Mr. Felix Singer, the founder and general manager of the Bank fuer Electrische Industrie and of the company which bears his name, will not join the Helios Company. To Mr. Singer belongs the credit of introducing the Walker system, of America, into Germany and other countries of the Continent, and his efforts have been attended with conspicuous success, his company having put down a number of important electric tramway and lighting installations in Europe.

Electric Light Burdens.—The *Pall Mall Gazette* contains the following:—

> Is it not time that the Board of Trade, which is supposed to watch over the interests of electric light consumers, stepped in and took some notice of the change from 100 to 200 volts which many, or most, of the companies are now bringing about? The 200-volt lamps take more energy per given candle-power, have shorter lives, cost more (in most sizes), and require dearer fittings than the old ones, besides considerably increasing the fire risk. The reduction in rate offered by the companies to induce people to agree to the change is quite inadequate to meet these really serious disadvantages, while the gain to the companies is very great, as the old mains are enabled to supply four times the number of lamps. Until something more is done towards giving the consumer a proportionate share in the gain, our advice to those who are asked to change is—don't.

Electrical Congress at Vienna.—An Electro-technical Congress is being organised by the Vienna Electrotechnische Verein, to be held in that city from June 14th to the 17th next. In addition to the reading of a number of papers, visits are to be paid to the large electrical engineering works in the district.

Semi-Permeable Membranes.—According to Ostwald, a semi-permeable membrane is both a conductor, like metals, and also an "iron sieve." Experiments made by J. Mijers, however, are not in accordance with the latter idea. The copper deposited on semi-permeable membranes is not a coherent mass, but is more of a spongy nature. A glass cylinder, closed by a membrane of copper ferro-cyanide on parchment paper, and filled with normal copper sulphate solution, is placed in an electrolysing vessel containing the same solution, and a current from two Bunsen's elements passed through; no copper is deposited on the membrane during the first half-hour, and it is only as the liquid in the cylinder is becoming colourless that the deposit is formed. If the cathode, which is placed in the cylinder closed by the membrane, is weighed both before and after the experiment, it is found that the amount of copper deposited exceeds by a considerable amount that previously contained in the solution in the cylinder, thus indicating that copper must have passed through the membrane. If acidified water and a platinum cathode are placed in a similar cylinder closed by a membrane, and this is then placed in an electrolytic vessel containing copper sulphate, even after a few minutes metallic copper is deposited on the cathode. The amount of this copper, after four hours, is more than 100 times that contained in the precipitate of copper ferro-cyanide on the membrane, which is not acted on by the acid, and retains its colour. Experiments have also shown that semi-permeable membranes are conductors differing entirely from metals. For example, if the anode and cathode in a copper sulphate electrolysis apparatus are separated by a semi-permeable membrane fixed between two ebonite rings and by a sheet of platinum of exactly the same size as the membrane, when the current passes, no metal is deposited on the membrane, but it is on the platinum, especially near the middle, none, however, near the margin, which is protected by the ebonite. The above is an abstract of a paper by J. Mijers in the *Rec. Trav. Chim.*, 1898, 17, 177—181.

A Large Chimney.—At the Ninety-sixth Street station of the Metropolitan Street Railway Company of New York, there has been built a chimney 353 feet high, with a 22-foot core. To build this chimney some 1,300 piles were driven into a foundation area 85 feet square, dug out 20 feet below station floor level. Most were driven 40 feet, but towards the last only 15 feet was possible. On this foundation 20 feet of concrete was laid down, and above this the chimney of 8,540 tons was built, commencing square 55 feet × 55 feet, rapidly battering for 10 feet, and by diminishing batters to 20 feet, and finishing at 39 feet square, thence parallel to 80 feet, but with chamfered corners. At 39 feet the section becomes circular, and to nearly 38 feet diameter at an elevation of 100 feet, whence the batter is $\frac{5}{16}$-inch per foot, until at 316 feet the diameter is 26 feet 10 inches. The top flange is 35 feet diameter. It is of iron, in 40 sections, and is anchored to a steel ring built in 14 feet below. There are 10 lightning rods above the cap. Well above the flue openings the structure is one at 90 feet, the inner chimney springs off at 22 feet inside diameter and 2 feet thick, diminishing to 8 inches thick at the top. Firebrick extends to 115 feet, and requires 120,000 bricks. Twelve ribs extend from the outer shell to within half an inch of the inner chimney. Wind pressures of 40 lbs. per square foot were calculated for. The stack, by Rankine's formula, should produce 2 inches of draught at 500° with 60° outside temperature, and it is expected to take the products from 115,000 lbs. of coal per hour, being at the rate of $1\frac{3}{4}$ lbs. per H.P.-hour of the 70,000 H.P. plant. The cost of the chimney was £20,000, which represents £1,200 per annum of interest, &c., at 6 per cent., or 7½d. per year per rated H.P. With these data, engineers may be able to make a comparison with fan draught. The cost appears to be very great, but 70,000 H.P. is a large power, and the annual charge of 7½d. per H.P. is not apparently serious.

Appointment Vacant.—The York Electric Lighting Committee want applications for the post of resident electrical engineer for the electricity works. See our "Official Notices" this week.

Institution of Electrical Engineers.—At the annual general meeting of the Institution on Thursday last week, the announcement was made that the premiums for papers read during the Session 1898-99 had been awarded by the Council as below :—

The "Institution Premium," value £25, to Mr. P. V. McMahon, member, for his paper on "Electric Locomotives in Practice and Tractive Resistance in Tunnels, and Notes on Locomotive Design."

The "Paris Electrical Exhibition Premium," value raised to £20, to Mr. W. Duddell and Mr. E. W. Marchant, associates, for their paper, "Experiments on Alternate Current Arcs by aid of Oscillographs."

Two Fahie premiums, none having been awarded in 1898, of £10 each. One to Prof. O. Lodge, F.R.S., member, and one to Mr. G. Marconi, member, for their papers entitled respectively "Improvements in Magnetic Space Telegraphy," and "Wireless Telegraphy."

Two extra premiums of £10 each, one to Mrs. Ayrton for her paper on "The Hissing of the Electric Arc;" the other to Mr. J. Elton Young, member, for his paper on "Capacity Measurements of Long Submarine Cables."

The senior "Students' Premium," value £10, to Mr. W. G. Royal-Dawson, student, for his paper on "Alternating Currents of very High Frequency."

The second "Students' Premium," increased in value to £10, to Messrs. M. R. Gardner and W. P. Howgrave Graham for their paper on "The Synchronising of Alternators."

The third "Students' Premium," value £5, to Mr. Leonard Wilson, student, for his paper on "The Effect of Governors on the Parallel Running of Alternators."

Extra "Students' Premium," value £4, to Mr. L. R. Morshead for his paper on "Enclosed Arc Lamps," and an extra "Students' Premium," value £3, to Mr. H. M. Dowsett, student, for his paper on "Electricity Meters."

The "Salomons Scholarship" for 1899-1900, value £50, was awarded to Mr. H. J. Thomson, a student of the Central Technical College.

The premiums and scholarship cheque will be presented at the first meeting of next session in November.

The total additions to the register during the 17 months covered by the report were 667, and 36 candidates were balloted for during the annual general meeting.

Electrolytic Decomposition.—An interesting paper on this subject by E. Bose occurs in the *Zeitschrift für Elektrochemie*, 1898, V. 14, 153—177. He states that he has repeated and confirmed the observations of Glaser on the electromotive force necessary for the decomposition of water, and then extended his experiments in order to determine the points at which decomposition begins in different solutions. The general conclusions arrived at are as follows :—The determination of the point of decomposition is preferably made with the help of a continuously-increasing voltage and not by a step-up arrangement. This is accomplished by winding the resistance spirally on an insulating drum which is driven at a suitable rate by a motor. The rate can also be varied by a system of change wheels, whilst the resistance itself is continuously tapped all along its length by a small loose pulley bearing on the wire and running on a shaft parallel with the axis of the drum. Deviations of the curves from the theoretical form, especially with very dilute solutions, are due to differences in the concentration of the electrolyte round the electrodes, and hence the most accurate results are obtained by using the smallest possible currents. Extremely well marked points of decomposition are obtained on the deposition of solid substances, whilst if soluble substances, and especially if gases are liberated at the electrodes, the curves show a gradual rounding off near the point of decomposition instead of an abrupt change of curvature. The influence of temperature and concentration on the electromotive force required for the decomposition of silver nitrate solutions was also carefully investigated, and the results are given in tabular form. Solutions of copper salts show two characteristic cathodic points of decomposition, the lower one of which is probably due to the presence of $\overset{+}{Cu}-\overset{+}{Cu}$—ions. An oxygen electrode is strongly depolarised in solutions of mercurous salts. Silver is deposited from nitric acid solutions as a singly charged ion, $\overset{+}{Ag}$. In general, acids show just as many points of decomposition as there are ions split off on progressive dissociation. Both acids and alkalis show the anodic point of decomposition, observed by Glaser, at 1·08 volt, due to the presence of $\overset{--}{O}$ ions, and corresponding to the point of reversal of the gas battery.

The Stranding of the "Paris."—Some correspondence has been appearing in the *Times* regarding the dangers to ships passing in the neighbourhood of the Manacles. The magnetic deflection of the compass theory has been raised again.

Admiral Algernon De Horsey writes from Cowes, and says that the theory is hardly worth contradiction. The same pretended excuse has been put forward in the case of the *Serpent* at Finisterre, and other vessels carelessly lost. The scientific and responsible officers of the Admiralty will tell anyone that "there is no magnetic attraction whatever at the Manacles." But, if it did exist, "one may ask why it should be reserved for the *Paris* and *Mohegan*, when thousands of iron and steel ships navigate that part of the coast of Cornwall in safety ?"

Mr. J. R. Wigham, of Dublin, writes to blame the inefficiency of the Lizard light (electric) as the great cause of the stranding of the *Paris*. He blames electric lights in lighthouses as being worse than useless in fog or mist. He produces various statements by nautical experts to support that view, and hopes that the Board of Trade will call upon Trinity House to substitute large gas flames for the Lizard electric lights.

Thermo-Electric Combination.—Prof. W. F. Barrett, of the Royal College of Science, Dublin, writes to the *Engineer* as follows :—"In your admirable report of the Royal Society soirée of May 3rd, you refer to a new thermo-electric combination which I exhibited, consisting of a nickel manganese iron alloy, coupled with nearly pure iron as the second metal. This combination, as you correctly state, I found to give a nearly constant electromotive force (4,000 micro-volts) from 300° C. to 1,000° C.; that is to say, the thermo-electric current is practically independent of temperature through the enormous range of 700° C. It is this fact, which is, I believe, unique in thermo-electricity, that renders the combination so interesting from a theoretical point of view. Probably it may also be valuable practically, not, of course, as a pyrometer, but for attaining a constant electromotive force ; 250 of such couples—the cool junctions being kept at 0° C.—will give just 1 volt in any common gas flame. Will you permit me to add that the alloy referred to is one of a series of patented iron alloys made by Hadfield's Steel Foundry Company, Limited, Sheffield, and is one of those recently referred to in Mr. R. A. Hadfield's paper on nickel iron alloys read before the Institution of Civil Engineers. I need hardly remind your readers that Mr. Hadfield's numerous and important researches on alloys have added much to our knowledge."

Early Experiments in Wireless Telegraphy.—We have already referred to Prof. Hughes's experiments on the transmission of ethereal impulses made as early as 1879, but unfortunately not published at the time. Prof. Elihu Thomson, in a letter to a contemporary, points out that he and Prof. Houston had made some experiments of the same kind in 1875, which were described at the time in the *Journal* of the Franklin Institute. One terminal of an induction coil was connected to the water pipes, while the other was connected by 2 or 3 feet of wire to an insulated metallic vessel. When sparks passed between the discharge terminals 2 or 3 inches apart, short sparks could be drawn from metallic objects all over the building. One curious phenomenon was observed, for which Prof. Thomson offers no explanation. There was a piece of copper wire, having at its end a loop, projecting from the wall in one corner of the chemical laboratory, which was in the basement of the building. This wire had no direct connection with the coil, but did rest against a steam apparatus, which in turn was connected to the water supply piping. In exploring the chemical laboratory for evidences of the presence of waves, Prof. Thomson happened to note a slight ticking sound when he came near the wire, and at last succeeded in locating it in the end of the wire itself by placing the loop close to his ear. Electrostatic forces, due to the periodical charges on the end of the wire, may have had something to do with it.

Appointments Vacant.—The Hull Tramways Committee want two junior electrical assistants as switchboard attendants. See "Official Notices."

The Paris 1900 Exhibition and American Electrical Exhibits.—The following extract from the *Pittsburg Press* of recent date shows that one American electrical engineering firm intends to have a striking display at the Paris Exhibition next year :—

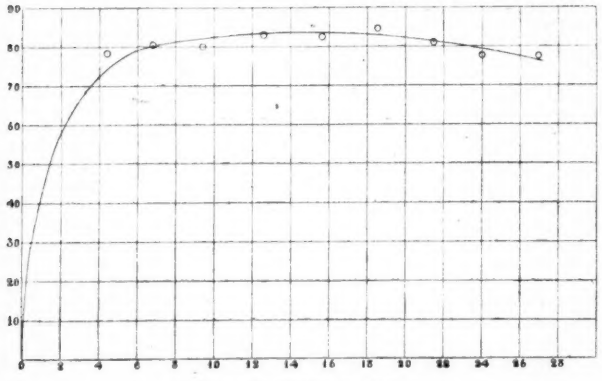
> The Westinghouse Company, having gained many victories over its formidable rival, the General Electric Company, of Schenectady, intends showing the savants of Europe what can be done in Pittsburg when it has the whole world to compete with in the manufacture of automobiles as well as making electric motors, cars, and lights. That is why two expert men are now in Paris looking after the big exhibit the local concern will have going at the Exposition in 1900. Six more men will leave next week for the same purpose.

To be forewarned is to be forearmed, and we have no doubt the Schenectady company will attempt to beat the Pittsburg company, even at preliminary newspaper puffs, in which our trans-Atlantic brethren excel. We hope English electrical engineering firms will prepare in good time, and that they will not allow America to monopolise the attention of visitors in the electrical engineering branch of the Exhibition. A good display of English electrical machinery and apparatus will help to convince our foreign friends that in spite of much shouting on the part of Americans concerning the capture of the English market, the English electrical engineering industry is still vigorous and fairly prosperous, and that though we don't make as much noise as our rivals, our silence must not be taken to signify we have nothing to shout about. The efficacy of "shouting" is only slowly dawning upon the intelligence of the British electrical manufacturer. No doubt in time he will fully endorse the sentiment conveyed in the following rhyme which, needless to say, first appeared in an American paper :—

> The man who whispers down a well
> About the goods he has to sell,
> Won't reap the gleaming golden dollars
> Like one who climbs a tree—and hollers.

Efficiency Curve of a Langdon-Davies Motor.—The accompanying curve represents the efficiency of one of the Langdon-Davies Electric Motor Company's standard pattern 25-H.P. brushless motors, tested on a single-phase system, 200 volts, 86 periodicity. It will be noticed that the efficiency rises to 80 per cent. at less than a quarter of full

Test of 25 B.H.P. Motor. Tested at 200 V., 86 ~.



Actual B.H.P. obtained on the pulley.

Efficiency Curve.

load, and therefore that the average efficiency obtained is exceptionally high for any class of engine, whether electric motor or otherwise. It is stated that this motor starts on light load with less than full load current, and without the employment of slip rings or other method of introducing resistance into the armature circuit.

Fatality.—A foreman electric linesman, employed by Messrs. R. W. Blackwell & Co., was killed on Wednesday last week while fixing electric wires for the Liverpool trams. In the course of his work in Upper Parliament Street deceased climbed a ladder which smashed and threw him to the ground. In the evidence it was stated that he should not have used a ladder, as a tower waggon was provided for the purpose. A verdict of "Accidental death" was returned.

Buffalo and Niagara Electric Railways.—The International Traction Company, which is the $15,000,000 syndicate that has purchased the electric railways of Buffalo and the Niagara locality, including those of Lockport and two great bridges across the Niagara gorge, has taken over and re-organised all of its new properties. In this re-organisation, Hon. W. Caryl Ely is made president of the various companies, with Burt Van Horn as general manager. It was Mr. Ely who built the Buffalo and Niagara Falls and the Buffalo and Lockport electric railways, and his strength in the electric railway world has made him a proper selection as president of the great new syndicate. He is a lawyer by profession, and stands high in the legal field. The two bridges owned by the company are the upper steel arch near the Falls of Niagara, recently built to replace a suspension bridge, and the new suspension bridge now in course of erection across the Niagara at Lewiston. These bridges are expected to make it possible for the company to operate a belt line about the Niagara gorge. However, at this writing the trolley connection with the new suspension bridge is not visible, owing to the fact that the Gorge road is not yet being put in condition for operation this summer. Still, the receiver of the property is actively engaged in trying to dispose of it in order that it may be operated during the summer, it being recognised that the property would greatly depreciate if allowed to remain idle during the busy summer season at the Falls. General-manager Van Horn has stated that the International Traction Company will maintain a through electric car service between Buffalo, N.Y., and Queenston, Ont., during the summer, thus making it possible to travel from point to point mentioned without changing cars. Such service would be operated out of Buffalo over the tracks of the Buffalo and Niagara Falls road to Niagara Falls, where connection would be made on the upper steel arch bridge with the tracks of the Niagara Falls, Park and River Railway, the road that skirts the cliff on the Canadian side, and thence to Queenston, where boats may be taken across Lake Ontario for Toronto, Ont., and the Thousand Islands of the St. Lawrence. This is a most popular scenic route and one travelled yearly by thousands of tourists. In the interest of the International Traction Company, and in order that their cars may make connection with the upper steel arch bridge, a Bill has been introduced in the New York State Legislature amending a State law and giving the Commissioners of the New York State Reservation at Niagara the right to grant permission for the construction of a surface railway along the Riverway, which is a street running on the east side of Prospect Park and owned by the State, between Falls Street and Niagara Street, one block. This license is to be revocable and granted under such conditions as the Commissioners may prescribe. The Bill is likely to become law, and if it does the construction of the surface road will relieve the congested condition of trolley car operation on Fall Street, at the foot of which thoroughfare all of the Niagara Falls and Buffalo cars now turn.

Accident on the City and South London Railway.—Last Friday's evening papers had some rather amusing and startling statements, remarkable for their extravaganza, regarding mishaps which occurred on the City and South London Railway. We prefer the account of Mr. P. V. McMahon, the engineer, who writes :—"What really happened to the train leaving Stockwell soon after 10 o'clock on Friday morning last, concerning which such exaggerated reports appeared in the evening papers, was that one of the armatures on the locomotive had a short circuit on the commutator which partly burnt through the spring holding on the brush plates. This happened about 150 yards outside Stockwell Station, and the guard went back to bring another locomotive to push the train on to the Elephant and Castle, where there is always a locomotive in readiness in case of a breakdown. Just on entering the Elephant Station the brush plate with the burnt springs dropped down on to the conductor, causing another short circuit. The total delay to the train was 12 minutes. With regard to there being any danger of the following train running into the disabled one, it is an absolute impossibility for such a thing to happen, as we use the 'absolute block' system of signalling, and the signalman at Stockwell cannot let one train leave until the train in front has left the next station."

Some Recent Researches on the Electrolysis of Alkali Chlorides.—A somewhat important paper on this subject is to be found in the *Zeitschrift für Elektrochemie*, 1898, Vol. v. (5), pp. 52—76, where H. Wohlwill recounts his researches on the behaviour of sodium chloride when electrolysed. This substance was chosen because it is a fair type of the alkali chlorides. Besides the ordinary formation of caustic alkali at the cathode and chlorine at the anode, certain other processes take place during the electrolysis of such a solution, which give rise to the salts of the oxy-acids of chlorine. The chief of these are hypochlorites and chlorates, and also, under certain conditions, perchlorates. The question, which is of both scientific and practical interest, is, how a solution containing initially only the anions $\overline{Cl}$, $O\overline{H}$, and $\overline{O}$ becomes charged with the anions of the hypochlorites and chlorates, viz., $\overline{Cl}O$ and $\overline{Cl}O_3$. In order to solve the problem, the author has adopted the method used by Glaser for the study of the electrolysis of aqueous solutions generally. The same problem has been attacked by Oettel (*Zeitschrift für Elektrochemie*, I., 69) and also indirectly by Haber (*Zeitschrift für Anorg. Chem.* XVI., 198 and 329); but since the author's intention was to isolate the primary reactions, he took precautions which would enable him to observe the initial direction of the reactions and not the final product, as was the case with Oettel's and Haber's experiments. For the author's purpose some of the objections which may be raised against the methods of other investigators are as follows:—The duration of the experiments is too long; the products of electrolysis are not separated from each other, and consequently undergo further action by the current; the composition and concentration of the solution is constantly changing, &c. By avoiding these conditions, which give as a result only the sum of different reactions which cannot be distinguished from each other, the author has arrived at the following conclusion:—(1) With as low an anodic electromotive force as 1·2 volt (against a hydrogen electrode), formation of hydrochlorite takes place. With an E.M.F. of about 1·2 – 1·3 volt the reaction is almost quantitative, apparently according to the equation:—

$$\overline{Cl} + \overline{O}\,(+\,+) = \overline{Cl}\,O.$$

(2) A more extensive formation of hydrochlorite only begins above 2·1 volts, and this depends on a secondary chemical action of the liberated chlorine on the alkali present. (3) Chlorate is formed:—(*a*) By an ionic reaction on supplying positive electricity, and not (*b*) by a direct union of $\overline{Cl}$ and $O\overline{H}$ ions (as maintained by Haber), but more probably from the $\overline{Cl}\,O$ ions already formed in the solution, according to the equation—

$$2\,\overline{Cl}\,O + O\overline{H}\,(+\,+) = Cl\,O_3\,H + \overline{Cl}.$$

International Congress of Telegraphists.—The above Congress was inaugurated at Rome on Wednesday. Among those present were the Marquis di San Guiliano, Minister of Posts and Telegraphs, the authorities, and numerous Italian and foreign delegates, among whom were Mr. Garland, representing Great Britain; MM. Baudelot and Amiot, France; and Mr. Burton, the United States. The Marquis di San Guiliano made an opening speech, and other speakers followed. The Marquis di San Guiliano was appointed honorary president by acclamation, and declared the Congress open. The Marquis di San Guiliano opened the competition for telegraphists, for which there were 80 entries.

Electric Launches.—Electric launches are now plying for hire regularly on the Colombo Lake. Each of the two new boats, the *Venus* and the *Water Nymph*, will accommodate 50 passengers, and each carries 50 cells.

Presentation.—Mr. H. St. Hill Mawdsley, the chief electrician to the Newton Electrical Works, Limited, Taunton, was presented on the 24th ult. with a handsome clock and vases by the employés on the occasion of his marriage.

The Ferranti Valve Gear.—The valve gear of the Ferranti engine was recently described in the *Engineer*, and is found wanting by a correspondent of that journal, Mr. James Dunlop, on the ground that being a trip gear it is not operated by a wrist plate, and that at speeds of 150 revolutions per minute the clearance of a trip gear is necessarily too large for the engaging velocity of the trip edges, and there must be undue noise and wear. With a wrist plate a good deal of time can be allowed over the angle of movement, which represents trip clearance and quiet results. It is complained that being without the wrist plate contact is made at double speed. Further, the range of trip is only one-third the stroke, and practically only 90° of the movement of the eccentric is available for the operation of working off the clearance and lap lead and port opening and disengaging. Mr. Dunlop is of opinion that the wrist plate is not easy to improve upon, and considers that many designers are too anxious to make fresh designs, irrespective of any necessity for such, and of the fact that the new designs are not necessarily improvements. At one time every firm of engine makers considered it a point of honour to have their own peculiar valve gearing; some of them were very good, others merely curious pieces of mechanism. Evidently, if Mr. Dunlop's criticism is well founded, the desire to be original still clings to the steam engine maker.

Newington Electricity Works.—To-morrow (Saturday) afternoon there is to be an inspection of the Vestry's electric lighting station now approaching completion in Penrose Street, Walworth. It is anticipated that supply will commence in about a month, but for some time past current has been taken from the South London Electric Supply Corporation for temporary supply to consumers. The scheme as adopted by the Vestry was for 50,000 lights, plant being installed in the first instance for 10,000 8-C.P. lamps.

Strike of French Engineers.—A Reuter's despatch on Tuesday from Paris says that a general strike is stated to have occurred at the great gun foundries and engineering works of Creusot, and that work is completely at a standstill. The *Aurore* says that 4,000 men have already come out, and that a general strike has been decided upon. According to the *Journal du Peuple*, 1,500 men left off work on Monday morning, and in the evening were joined by 2,500 more. The same newspaper states that 10,000 men would be on strike on Wednesday.

The Recent Electric Fatality at Southampton.—The Secretary to the Board of Trade has written to the Council reminding the Corporation that they ordered the supply of electricity, although aware that the mains were unfinished, and the Board could therefore not accede to the suggestion that the explanation offered relieved the Corporation from responsibility for the accident.

Electric Traction.—Mr. J. Clifton Robinson, M.I.E.E., read a paper on Monday at the Cleveland Institution of Engineers, Stockton-on-Tees, on "Electric Traction on Tramways." Mr. Robinson said, having inspected every new invention, his judgment was that the trolley system held the field. Indeed, it was the only system to which a community, a corporation, or a capitalist could reasonably turn.

NEW COMPANIES REGISTERED.

Nalder Bros. and Thompson, Limited (62,214).—This company was registered on May 19th, with a capital of £20,000 in £1 shares (10,000 £6 per cent. cumulative preference), to acquire and carry on the business of electrical and mechanical engineers and electrical apparatus manufacturers carried on by Francis H. Nalder and Ernest Thompson at 34, Queen Street, E.C., as "Nalder Bros. and Thompson." The first subscribers (each with one share) are:—F. H. Nalder and E. Thompson, 34, Queen Street, E.C., engineers; E. T. D. Wilson, 61, Gracechurch Street, E.C., timber merchant; Algernon L. Collins, 31, Lawrence Lane, Cheapside, E.C., solicitor; Bernard Wild, 104, Westborne Terrace, Hyde Park, W., solicitor; Ernest J. White, 12, Delamere Street, Paddington, W., clerk; Vaughan Page, Haldon House, Mottingham, Eltham, S.E., clerk. The first directors (to number not less than two nor more than four) are F. H. Nalder and E. Thompson; qualification, £500; remuneration as fixed by the company.

Electrical Industries, Limited (62,215).—This company was registered on May 19th, with a capital of £5,000 in £1 shares, to construct, execute, carry out, equip, maintain and work electric lighting, telephonic, telegraphic, power supply and other public works The first subscribers (each with one share) are:—Edwin F. Cossor, 63, Queen's Crescent, Haverstock Hill, N.W., gentleman; Leo B. Feeny, Abbotsford, Coventry Park, S W., gentleman; Alfred E. Spearman, 70, Elgin Avenue, Maida Vale, W., gentleman; Arthur E. Cossor, 80, Agamemnon Road, West Hampstead, gentleman; W. Moore, 175, Oxford Road, Barnsbury, N., gentleman; John H. Goldsmith, 55, Wirtemberg Street, Clapham, S.W., gentleman; Francis H. Hurdle, 53, Matcham Road, Leytonstone, clerk. Registered without articles of association.

English Electro-Metallurgical Company, Limited (62,225).—This company was registered on May 20th, with a capital of £700,000 in £1 shares (300,000 6 per cent. cumulative preference), to acquire the undertakings of Elmore's Patent Copper Depositing Company, Limited, Elmore's Wire Manufacturing Company, Limited, Elmore's American and Canadian Patent Copper Company, Limited, and Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, and to carry on the business of metallurgists, manufacturers of and dealers in copper and other metals, electricians, electrical and mechanical engineers, suppliers of electricity and manufacturers of electrical apparatus. The subscribers (each with one share) are:—W. Dunn, 31, Abchurch Lane, E.C., solicitor; G. F. Schmettau, 91, Crowxted Road, West Dulwich, law student; C. W. Longman, 181, Leathwaite Road, New Wandsworth, gentleman; W. Boyes, 2, Carpenter Villas, Hill Street, Peckham, S.E., gentleman; A. H. Wynne, The Nook, Southend-on-Sea, accountant; H. Mason, Finden Cottage, Dulwich Village, S E., gentleman; and Wallace Read, 190, Friern Road, East Dulwich, S.E., gentleman. The first directors (to number not less than three nor more than eight) are the Marquis d'Hautpoul, Daniel Bethmont, Arsène Chaumier, Arthur Demmler, Frank E. Elmore, A. Stanley Elmore, and Lewis J. Firth; qualification, 500 shares; remuneration, £200 each per annum, and £50 extra for the chairman.

Automatic Photoscope Syndicate, Limited (62,262).—This company was registered on May 24th, with a capital of £25,000 in £1 shares, to enter into agreements (1) with John Rose, and (2) with John Rose of the first part, and Alfred Rose and Alfred Coop of the second part, and to carry on the business of exhibitors of stereoscopic and other views, artists and manufacturers of automatic photoscopes and other apparatus for the production of stereoscopic transparencies and animated or coloured photographs, and all other electrical and scientific apparatus. The first subscribers (each with one share) are:—J. C. Hanser, Within's House, Radcliffe, manufacturer; Herbert E. Webster, Bull's Head Chambers, Manchester, oil refiner; Thomas Coop, 13, Wilkinson Street, Leigh, mill furnisher; J. H. Rose, 64, Frithville Gardens, Shepherd's Bush, W., telegraph engineer; E. B. Openshaw, 4, Chapel Walks, Manchester, agent; A. E. Ellis, 4, Chapel Walks, Manchester, agent; and Nathan Yates, 4, Wood Street, Bolton, chartered accountant. The first directors (to number not less than two nor more than seven) are to be nominated by the subscribers; qualification, £250; remuneration as the company may decide.

D. H. Bonnella & Son, Limited (62,264).—This company was registered on May 25th, with a capital of £15,000 in £1 shares, to acquire the business carried on at 58 and 60, Mortimer Street, and 43, Kirby Street, Hatton Garden, London, and to carry on the business of ivory, wood, and bone turners, electrical and mechanical engineers, &c. The first subscribers (each with one share) are:—D. H. Bonnella, wood turner, A. J. Bonnella, electrical engineer, and Mrs. M. Bonnella, all of 58, Mortimer Street, W.; Mrs. K. Bonnella, 13, Harold Road, Hornsey; H. J. Batson, silversmith, and A. E. Batson, cabinet maker, both of 42, Brewer Street, W.; and A. Cutter, 48, Clifton Hill, N.W., dentist. The first directors (to number not less than two nor more than five) are D. H. and A. J. Bonnella; qualification, 250 shares.

Mechanical and Electrical Power Company, Limited (62,314).—This company was registered on May 27th, with a capital of £5,000 in £1 shares, to carry on the business of electrical and mechanical engineers, electricians, suppliers of electricity for the purpose of light, heat, motive power, or otherwise, manufacturers of and dealers in electrical apparatus, &c. The first subscribers (each with one share) are:—William G. Blakiston, 65, Lincoln's Inn Fields, gentleman; Hinton J. Bailey, 65, Lincoln's Inn Fields, gentleman; Alfred Michelson, 65, Lincoln's Inn Fields, gentleman; William Chapman, 65, Lincoln's Inn Fields, gentleman; Fredk. W. Braithwaite, 59, Hargrave Park, Junction Road, N., clerk; Edward T. McCarthy, 195. Brecknock Road, N., clerk; George W. Mollet, 36, Aden Grove, Green Lanes, N., clerk. Table "A" mainly applies.

CITY NOTES.

The Harrow Electric Light and Power Company, Limited.

THE report to be presented to the shareholders at the third annual general meeting on May 30th, 1899, states the company's business has continued to increase very satisfactorily, the equivalent of about 2,715 8-C.P. lamps having been connected in 1898 against 1,540 in 1897. At the end of 1897 there were 87 consumers connected, with the equivalent of 5,435 lamps, whilst at the end of 1898 there were 145 consumers with 8,150 lamps. In the first quarter of 1899 the equivalent of about 823 lamps have been connected, so that the increase in business is steadily continuing. The remainder of the buildings of Harrow School were wired during 1898. The output for 1898 was 79,419 Board of Trade units sold against 50,109 in 1897. The amount received for current supplied, meter and installation rents, &c., was £2,786 0s. 4d. in 1898 as against £1,730 3s. 3d. in 1897. To meet the steadily rising demand the directors have found it prudent to order another boiler. The directors pointed out in their last annual report that they thought the company would shortly be in a position to reduce the price of current. After careful consideration they determined to make a reduction as from Lady Day, 1899. Notice was accordingly given to customers and duly advertised of a reduction from 8d. to 7d. per Board of Trade unit, the consumer having the option of adopting the demand indicator system and being charged at 8d. per unit for the number of units corresponding to a consumption at the rate of his maximum demand for two hours a day during the Christmas and Lady Day quarters, and one hour a day during the Midsummer and Michaelmas quarters, and at 6d. per unit for all units in excess of that number. An explanation of the system was also circulated. The directors have continued their policy of extending the mains where a reasonable percentage on the outlay can be obtained, and new mains were laid in 1898 in South Hill Avenue, Sheepcote Road, Bessborough Road and Headstone Road. It was found necessary, owing to the increase of load to extend the existing feeders and put in an additional feeder to supply the Greenhill district in which there had been a great accession of custom. The cost of these extensions amounted to some £2,750. Consumers still avail themselves readily of the system of wiring on rental, and in the year 1898 34 customers had their houses so wired. The directors are also glad to report that the result of the company's working the station themselves has been satisfactory. In the first half-year of 1898, when the station was worked by Messrs. Cromptons, the cost was £497 4s. In the second half of the year, which is of course the heavier, the cost was roughly £520, whereas, had Messrs. Cromptons still had the contract, it would have been over £620. The directors were fortunate in securing as their resident engineer, Mr. A. H. Shaw, who had for some time previously been with Mr. Hawtayne. Of the additional £2,500 debentures offered in 1898, £2,300 were taken up within the year, and the remainder have been subscribed in 1899. At the end of 1898 the share capital up to £19,950 was taken up, and the directors offered the last £5,000 for subscription. £1,300 of this amount were taken up in 1899, and there are only £3,750 now available. As the capital expenditure at the end of 1898 was £35,916 12s. 10d., and as, in consequence of the increase of the company's operations, further expenditure will shortly be necessary, it will be seen that more capital is required. An additional boiler is wanted to meet the demand which is coming upon the station in the autumn, and another steam dynamo will be required in 1900. The chief capital outlay is, however, caused by the continually increasing demands for the extension of mains and house installations. The rental system of wiring houses is the principal means of securing the custom of the villas with which parts of the neighbourhood are being so rapidly covered, and the nucleus of a business has been formed in these parts which is already profitable, and which promises in a short time to become extremely so. The need for a much larger capital than was at first contemplated is not one therefore which calls for further explanation, and it has to be met. The directors propose to provide for it by increasing the authorised capital by £10,000, and by providing that of the whole capital so authorised an amount not exceeding one-third may, in the discretion of the board, be constituted preference shares bearing a preferential dividend of 4½ per cent. If the resolutions embodying these proposals are carried, the directors propose to issue £1,400 of such preferential shares at once. With the increase in the company's business the earnings of the current year ought to be sufficient to provide for the interest on the debentures and preference shares, and to pay a dividend of 4 per cent. on the ordinary shares. The directors hope that the preference shares may be subscribed and held, as the debentures have been, by their friends at Harrow. The £150 voted for directors' fees for 1898 was paid to them, and the shareholders are asked to decide upon their remuneration for the year 1899. As the result of the year's working, after paying interest on debentures and mortgages, there is the sum of £716 7s. 6d. available for dividend. Out of this the directors propose to pay off the balance of the preliminary expenses, £166 12s. 1d., to write a further £25 off leasehold property, to pay off a further £52 14s. 8d. legal charges, and £8 11s. 1d., the balance of the cost of the working contract, and to pay a dividend of 2½ per cent., which will absorb £449 7s. 9d., leaving a balance of £14 1s. 11d. to be carried forward.

Rand Central Electric Works, Limited.

THE annual ordinary general meeting was held last week at Winchester House.

Sir C. RIVERS WILSON, who presided, explained that the delay which had occurred in holding the meeting was due to the loss of the accounts while in course of transmission to this country. The accounts showed that at the end of the past year £16,000 was outstanding in respect of money due for electricity supplied, and so forth. That might seem to some of them rather a large amount, and it would, therefore, be satisfactory to them to hear that £14,000 of it had since been remitted to this side. The item of £29,748, payable by Messrs. Siemens & Halske, included £5,742, being the deficiency on the working of the year, the balance representing the 8 per cent. on the capital which, under their guarantee, that firm had to provide. While the amount of horse-power contracted for was, on the average, about 1,846, only 965 horse-power—equal to 42 per cent. of the total

capacity of the works—was supplied. The explanation of that apparent discrepancy was that, as the power under contract was mostly taken intermittently, the company were in a position to contract for a supply considerably in excess of 2,300 horse-power without enlarging the present installation. This was really a question of arrangement with the company's customers as to the times and manner in which they would take their electrical supply. As a company, they were still passing through what he might call an experimental period, but they felt perfectly safe so long as the guarantee of Messrs. Siemens & Halske lasted. The board had, therefore, thought it their duty to proceed with the utmost caution, and Messrs. Siemens and Halske agreed with them as to the inadvisabil ty of "rushing" matters. So long as the works were imperfect in their operations new customers would be disinclined to deal with the company, but when the works were freed from all reasonable chance of accident and interruption the company would be in a position to do a larger business. The guarantee of Messrs. Siemens & Halske would terminate at the end of the present year, but his belief was that, by that time, the works would be in such a state of perfection as to enable them to welcome all comers. After replying to a complaint that the directors did not propose to place to the reserve fund the amount stipulated for under the equipment contract, and that the sum to be written off for depreciation was inadequate, he said that he and his colleagues looked forward to the future of the company with the same confidence as they did when they took their seats at the board. With their usual promptitude, Messrs. Siemens & Halske had remitted the whole of the sum which they were bound by their guarantee to provide for the purpose of a dividend. He concluded by moving the adoption of the report.

Mr. A. Barsdorf seconded the motion, and, after some remarks from Mr. Sigismund Cahn, it was agreed to with one dissentient.

Castner-Kellner Alkali Company.

The report for the year ended March 31st last, to be submitted to the meeting to be held in London on 30th ult., states that the works, consisting of four installations of 1,000 H P. each, are now fully at work, and the plant and process are working satisfactorily. The total outlay on the freehold land, buildings, plant, and railways has been £292,819. The trading account shows a profit of £31,980, after having made adequate allowance for the efficient maintenance of the working plant. This has been earned by the running of the first installation for the whole year, the second for nine months, the third for six months, and the last installation was only fully completed just before the expiration of the year's working. The profit and loss account shows a net profit of £29,554, which, with £8,678 brought forward from last year, less directors' and auditors' fees for that year, amounting to £1,105, leaves £37,127. An interim dividend at the rate of £8 per cent. per annum has been paid for the six months ending September 30th last, which absorbed £12,000, leaving an available balance of £25,127. Out of this the directors propose to pay a further dividend at the rate of £8 per cent. per annum for the six months ended March 31st, and to appropriate £2,785 in writing off preliminary expenses, which include £655 for the issue of debentures, to appropriate £5,000 for depreciation, and to carry forward the balance, amounting to £5,342. The judgment of Mr. Justice Bigham, which was given in August last in favour of the company in the action brought against the Commercial Development Corporation for an infringement of one of their patents (not in use by the company), was reversed in the Court of Appeal in April, though the Court was divided in opinion, as one Lord Justice delivered judgment in favour of this company. The directors have been advised to appeal the case to the House of Lords.

The third annual general meeting of this company was held on Tuesday at the Cannon Street Hotel, Mr. William Mather presiding.

The Chairman remarked that the works undertaken at the formation of the company, consisting of four installations of 1,000 horse-power each, were completed towards the close of the month of March. During the year under review, therefore, the four installations had been fully at work, although for different periods. The first installation had been at work for the whole of the time, the second and third for a part of the time, and the fourth installation, as he had said, was finished in March, just before the end of the financial year. It would be seen that the profit accruing from this work, which had involved the expenditure of the whole of the company's capital, had not been derived from the *maximum* output for which the works were built, and that the figures and dividend set out in the report must, in these circumstances, be considered the more gratifying. The directors were highly satisfied with the success of the process, and he would point out that the company did not depend wholly on the value of the patents it held, but the experience gained by the board during the last three or four years must be considered as of great value. Notwithstanding the fact that the installations had not been fully at work during the 12 months, some shareholders were under the impression that the company had been conducting its business in favourable circumstances during the last two years, inasmuch as the company had a favourable contract for the sale of a part of its products, and, further, that this contract might not be of long continuance after the lapse of another year. It did not concern him very much whether the contracts were renewed or not, as the company might very possibly receive other contracts. He also considered that the company in the future would be enabled to make a very fair return on their capital if they had no contract at all, and if they had to stand their chance in the open markets. As to the law suit, which had been given in their favour and then reversed in the Court of Appeal, the directors had been advised to take the case to the House of Lords. For the current 12 months the works would give the *maximum* output, and, whatever might be the price of the products in the market, he felt that there must be a satisfactory profit to the shareholders. The directors proposed to ask them for power to convert the issue of £100,000 debentures at 5 per cent., which were terminable, when issued, in three years, into an issue of £150,000, at a lower rate of interest, and of a more permanent character. He concluded by moving the adoption of the report.

Sir Henry Roscoe seconded the motion, which was adopted, as was also a resolution for increasing the borrowing powers from £100,000 to £150,000.

The West India and Panama Telegraph Company.

The forty-fourth ordinary general meeting of the members of this company was held on Tuesday at Winchester House, Old Broad Street, Mr. William Andrews, the chairman, presiding.

The Chairman, in proposing the adoption of the report, said that when he addressed the shareholders at the last meeting he was fortunate enough to be able to tell them from the chair that they were going to have a big balance for the half-year, and he was pleased to say that the result had proved the correctness of that statement. The receipts for the half-year ending December 31st, 1898, were £51,973 16s. 7d., as compared with £32,228 11s. 8d. for the corresponding period of 1897, thus showing an increase of £19,745 4s. 11d., and that in spite of certain reductions and losses by subsidies which from time to time had taken place, amounting in the half-year under review to £1,151, and to their having received £800 or £900 less owing to other causes. They must all wish that the reason for the large increase in their receipts had been different. Of course the whole thing was owing to the unfortunate Spanish-American war, and he would like to point out that the augmented receipts, although very satisfactory, did not pan out so largely as some of the shareholders calculated they would. Nevertheless, it was the largest amount the company had ever had the good fortune to deal with, and shareholders would remember that at the last meeting he was very particular in giving them several words of caution as to the uncertainties in estimating the traffic as telegraphed from the other side. Large reductions were made in January, 1898, and other considerable reductions had been made from time to time in the half-year under review. That further complicated the accounts, and then the competitive routes caused additional changes and interfe ences, and still further complications were caused by interruptions and by deviations of correspondence owing to the uncertainties of routes. Although, therefore, the accounts were eminently satisfactory, they worked out less in amount than the estimates, but the position might work out to be more favourable than the figures which they had before them showed. The board had been considering the question of telegraphing over estimated receipts. As long as there was substantial accuracy they had continued the practice, but they could not see their way to get over the uncertainties and the fluctuations, and they thought that, on the whole, the best interests of the shareholders would be served by their suspending for a period the publication of those inaccurate estimates; at all events, until some more settled conditions might be reached. Turning to the expenses, they were somewhat higher than for the corresponding period, £4,671 0s. 6d. more, and they were accounted for by repairs to cables, depreciation of ships, and increased maintenance owing to the hurricane. The salaries and wages had also slightly risen, owing to the extra work done. The result was that they were enabled to recommend the usual dividend on the preference shares and a dividend of 2s. 6d. per share on the ordinary shares, free of income-tax, making with the 1s. 6d. per share paid for the last half-year a total of 4s. per share on the ordinary shares, leaving a balance of £4,920 0s. 8d. to be carried to the next account. The largest dividend they had been able to declare on the ordinary shares for any one year since 1890 had been 2s., and that on only one occasion. The average dividend paid during the 10 years ending 1897 was only 1s. 1½d. per share, and as the shareholders were this year getting 4s., he thought they would agree that it was a satisfactory move in the right direction. Unfortunately, as he had said, the whole of that large increase was earned because of the Spanish-American war, and it was impossible to forecast the future traffic now that war was over. So far during the current half-year there had been a falling off of both words and money in the messages exchanged with the British West India islands, but there had been an increase at the foreign islands in the West Indies. Large revenues had also been made owing to the interruptions of other lines, but the entire position was so fluctuating and so obscure, that no reliable calculation could be made. It was discouraging that, notwithstanding the reductions made in the tariff, there should not only be no increase in the number of words exchanged with the British West Indian islands, but an actual decrease. He could understand a decrease of money, but the decrease in the actual number of words appeared conclusively to show that unless the British West India islands were afforded substantial encouragement they would fall behind in the race, even as compared with the other West India islands which were not British. It showed too pretty clearly that whatever the tariff for telegraphing might be, they could not have an active telegraph with a sluggish, stagnant, or retrogressive commerce, and he was afraid that was what we were getting now in the British West India islands. That condition of things he was afraid would continue until the Government came forward with some workable measure of improvement which would place the islands in a very different position from that which they occupied at present.

Mr. Henry Holmes seconded the adoption of the report.

Mr. Blackley urged the directors to again appeal to the Government to endeavour to obtain material aid for the shareholders, and was proceeding to read extracts from a letter of the late chairman of the company, Mr. Earl, bearing on the subject, but at the request of

the chairman he desisted. Continuing, he said that in his opinion it would be a good thing for the ordinary shareholders if the property of the company was offered to the Americans.

The CHAIRMAN said the directors had never failed to impress upon the Government and the Colonial Office the importance of the maintenance of the West India communications, and they had tried to get assistance in that quarter, but without success.

MR. H. W. BIRT said that, as one who had long been associated with the company, he knew the directors had never lost an opportunity of trying to obtain assistance from the Government, but he did not think it was wise to debate the question at that meeting, nor did he agree with the shareholder who had suggested selling the company to the American Government. He thought the shareholders had great reason to be thankful to the directors for what they had done for the company, and as they were now entering into the enjoyment of a little bit of dividend he would like to suggest that a bonus of 100 guineas be given to each of the directors.

MR. NEWTON, in supporting the suggestion, said the work of the directors during the last 20 years had been more onerous than the directing of any other telegraph company in the world. He did not believe there was ever any hope of their making much impression upon the Government with regard to granting a subsidy, and as to breaking up the concern, he did not think such a proposal was feasible. Certainly there would be no advantage to the ordinary shareholders, because the preference shareholders, who would rank first, would have to be paid their pound of flesh, and there would be nothing left for the ordinary.

The CHAIRMAN appealed to the shareholders not to continue the discussion.

MR. LAMBERT asked whether the chairman thought that the cession of Cuba to the Americans would lead to an increased business for the company.

The CHAIRMAN said that Cuba did not come into their system so much as Porto Rico, and that he was glad to say had given them an increase already.

The report was then adopted.

The chairman having been re-elected as a director,

MR. BIRT formally proposed a resolution voting each of the directors an additional 100 guineas for their past services.

MR. BLACKLEY seconded the resolution, which was carried, and the auditors having been re-elected, the proceedings terminated with a vote of thanks to the chairman for presiding.

The Clontarf and Hill of Howth Tramroad Company.—This company, having a share capital of £50,000 in shares of £10 each, and authorised borrowing powers to the extent of £25,000, is offering the whole of the share capital at a premium of £2 10s. per share. The company is authorised by a special Act of last Session to construct and work by electrical power a tramroad from the end of the Clontarf Tramway of the Dublin United Tramways Company at Dollymount to the east pier of Howth. The consideration to be paid by the company for the undertaking, fully equipped as a going concern, is £71,000. The contractors take payment as regards £50,000 in shares and as regards £21,000 in debentures at 4½ per cent. interest. This issue is made on behalf of the contractors, who will be entitled to the benefit of the premium at which the shares are issued.

Wycombe (Borough) Electric Light and Power Company, Limited.—This company has been offering £5,000 in £5 ordinary shares for subscription locally; £5,000 of ordinary capital and £15,000 debentures (5 per cent.) are subscribed by the Edmundsons' Electricity Corporation, Limited. The company has booked orders for 3,090 8-C P. lamps and 20 H.P. for motors.

Northampton Electric Light and Power Company.—At an extraordinary general meeting on May 26th a resolution was passed approving of the issue of 7,000 5 per cent. cumulative preference shares, to be allotted to applicants for a like number of ordinary shares. The sale of electricity in April was 42½ per cent. larger than the sale in April of 1898.

Stock Exchange Notices.—The Stock Exchange Committee has appointed Wednesday, June 7th, a special settling day in the City and South London Railway:—37,500 ordinary shares of £10 each, £2 paid, Nos. 22,501 to 60,000, and has ordered same to be quoted in the Official List.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending May 27th, 1899, were £1,435 16s. 5d.; aggregate to date £6,488 12s. 6d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending May 26th, 1899, were £3,816 18s. 9d.; corresponding period, 1898, £2,653 5s. 4d.; increase, £1,163 13s. 5d.

The City and South London Railway Company.—The receipts for the week ending May 28th, 1899, were £912; week ending May 29th, 1898, £1,012; decrease, £100; total receipts for half-year, 1899, £23,270; corresponding period, 1898, £22,678; increase, £592. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending May 27th, 1899, were £214 6s. 1d.; week ending May 28th, 1898, £147 1s. 3d.; increase, £67 4s. 11d. Total receipts to date, 1899, £3,260 8s. 7d.; corresponding period, 1898, £2,492 6s. 2d.; increase, £768 2s. 5d. Miles of track open week ending May 27th, 1899, 3; week ending May 28th, 1898, 3. Car miles run week ending May 27th, 1899, 4,324; week ending May 28th, 1898, 3,323. Number of cars, week ending May 27th, 1899, 11; week ending May 28th, 1898, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, May 26th, 1899, were as follows:—D. U. T. Co., horse cars, £2,265 8s. 5d.; ditto, electric cars, £1,357 5s. 5d.; D. S. D. Co., electric cars, £1,056 0s. 8d.; total, £4,678 14s. 6d.; corresponding week last year—D. U. T. Co., horse cars, £2 783 9s. 8d.; ditto, electric cars, £454 9s. 9d.; D. S. D. Co., electric cars, £574 5s. 2d.; total, £3,812 4s. 2d.; increase, £866 10s. 4d.; aggregate to date, £72,985 15s. 7d.; ditto last year, £68,252 15s. 1d.; increase to date, £4,133 0s. 6d. Worked:—The mileage open is 18 miles electrically, 26 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending May 28th, 1899, amounted to £1,825; corresponding week last year £1,412; increase, £413.

The South Staffordshire Tramways Company.—The receipts for week ending May 26th, 1899, were £948 6s. 5d.; aggregate receipts for 21 weeks, £13,264 18s. 8d.; week ending May 27th, 1898, £601 7s. 9d.; aggregate receipts for 21 weeks, £12,445 18s.

STOCKS AND SHARES.

Wednesday Evening.

THE principal interest of the week has, of course, centered round the attitude of the Corporation of London with regard to the electric lighting of the City, with special reference to the existing agreement between the authorities and the City of London Electric Lighting Company. The result of the meeting at the Guildhall on Monday had a curious effect in the Stock Exchange, for diametrically opposite views were taken by different members of the "House" whose opinions upon the question are considered of weight. While it was argued in one direction that the Corporation was evidently willing to treat the company in a liberal spirit, the more pessimistic spirits point to the 80 members of the Council, out of 120, whose vote was cast against any purchase proposals. The price of the shares has been erratic, rising at first upon the Committee's recommendation, but becoming weaker as it began to be more and more recognised that apparently the company is bound to face another competitor within the charmed line, or else reduce the price of its unit from its present maximum of 8d. to 5d. The making-up price of the shares on Monday was 16, as against 17½ three weeks ago. Other electric lighting shares are quiescent, and our favourite for the rise is still Charing Cross.

The "making-up" price list exhibited but few noticeable changes, but South Londons made up at 4½, or 18s. 9d. better than on May 10th. Westminsters were ¼ down at 15, but no change had occurred in either County Ordinary, Metropolitan or St. James's. New Electric Supply dwindled 5s. to 2¼, and since then the price has still further relapsed to about 2. Buyers are few and far between, and these shares, which were rigged up to 13 not so very long ago, are now almost unrealisable.

New General Traction shares are receiving inside support, in order to pave the way for a new Preference issue at five guineas per share. The price of the existing shares is 5¼—½, so there does not appear much "catch" in the new issue, but we understand that it is nearly all underwritten, and will shortly be introduced in a public way. The price of the Ordinary shares has improved to 3¾—4. A lot of "good" buying of British Electric Traction has taken place during the week, largely on behalf of provincial supporters who regard the company's increasing business in the Potteries as likely to bring about a much higher price in the shares. It was only a fortnight ago that we directed attention to the developments that were taking place in Staffordshire, and investors are also looking the same way. Electric Construction hardened ¼ during the account which has just ended, but Elmore Copper and Elmore Wire both lost a fraction, making up at 1⅛ instead of ⅝.

The Welsbach dividend appeared at first sight to be very satisfactory, but when the market read the notice a little more attentively, and perceived that the distribution on the Deferred was only for the three months ending March 31st, 1898, instead of for the 15 months ending March, 1899, a sharp revulsion of feeling took place, and all the company's securities were freely offered. The manner of the Welsbach Company in making their announcement met with sharp criticism in the market, and the result of the 15 months' trading is considered distinctly disappointing.

Telegraph descriptions are rising once more, and a rise of nine points took place between the two May settlements in the price of Easterns, Great Northern added 1 to its price, and Eastern Extension ⅝, during the same period. Anglo-Americans are slightly harder. The Tramway section is quiet, without feature, and the market in Electric Traction stocks in New York has not yet recovered from its holidays on Monday and Tuesday, owing to the Decoration Day Commemorations.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, May 24th.	Closing Quotation, May 31st.	Business done during week ended May 31st, 1899. Highest.	Lowest.
124,400£	African Direct Telegraph, 4 % Debs.	100	...	...	...	101 —105	101 —105	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	85 — 90	85 — 90	87	...
905,560£	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	60 — 63	61 — 63	60¾	...
3,047,220£	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	111 —112	112 —113	112⅝	111
3,047,220£	Do. do. Deferred...	Stock	...	...	18s. %	12½— 13	13 — 13½	13 3/16	12⅝
205,151	Brazilian Submarine Telegraph	10	7 %	7 %	...	15½— 16	15½— 16	15⅝	15½
75,000£	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2½— 3	2½— 3	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	8 %	185 —195	185 —195	186	...
1,332,523£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	106	105
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	1½ %	...	⅛— ¼	⅛— ¼	...	...
16,000	Cuba Telegraph	10	8 %	7 %	8 %	9 — 10	9 — 10	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½— 19½	18½— 19½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	9½— 10½	9½— 10½	...	...
60,710£	Direct United States Cable	20	3 %	3¼ %	...	11¼— 11⅜	11¼— 11⅜	11⅜	11 7/16
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	102 —105	102 —105	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	6½%	7 %	...	164 —169	165 —170	168	164½
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	100 —104	100 —104	103	101
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	101 —104	101 —104	...	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	119 —123	116 —120	119	117
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	16½— 17	16½— 17	17	16¾
16,200£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	100 —104	100 —104	...	...
64,400£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	121 —125	121 —125	...	...
35,100£	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	100 —104	100 —104	...	...
46,500£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	101 —104	101 —104	...	...
300,000£	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	102 —105	102 —105	...	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	102 —105%	102—105%	104	102
180,227	Globe Telegraph and Trust	10	4½%	4½%	5⅛%	11⅛— 12¼	11⅜— 12¼	11⅜	...
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	15⅝— 16¼	15⅝— 16¼	15 5/16	15⅜
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	31½— 32½	31½— 32½	32½	31⅝
92,600	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	101 —104	101 —104	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	54 — 57	54 — 57	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	108 —111	108 —111	...	...
71,000	Montevideo Telephone, Limited, Ord., Nos. 1 to 71,000 ...	1	...	...	...	¼— ½	¼— ½	...	...
84,000	Do. do. 5% Pref., Nos. 1 to 84,000	1	...	...	...	⅜— 1	⅜— 1	...	...
490,000	National Telephone, 1 to 490,000	5	5½%	6 %	6 %	4½— 5	4½— 5	4 11/16	4⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅜— 5¼	4⅜— 5¼	...	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	99 —102	99 —102	100½	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅞— 1	⅞— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	...	105 —108	105 —108	107¼	106¾
11,839	Reuter's	8	5 %	5 %	...	7½— 8½	7 — 8 xd	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	131 —136	131 —136	132½	131½
58,000	United River Plate Telephone	5	5 %	6 %	...	4⅜— 5¼	4⅜— 5¼	5 1/16	...
151,733£	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000£	West African Telegraph, 5 % Debs.	100	5 %	5 %	...	99 —102	99 —102	100	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	103 —106	103 —106	...	...
889,521	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Telegraph	10	1 %	2%	...	1⅞— 2⅛	1½— 1¾xd	1 5/16	1⅛
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	10¾— 11½	10½— 11 xd	10½	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	9 — 10	8½— 9½xd	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	105 —108	105 —108	...	...
158,100£	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	11 — 12	11 — 12	11⅛	11⅛
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	5⅜— 6½	5⅜— 6½	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	6 %	6 %	8 — 9	8 — 9	...	...
100,000	Do. do. do. % Deb. Stock Red....	Stock	4½%	4½%	...	114 —116	114 —116	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	7 %	10 %	6 %	16 — 17	16½— 17½	17⅛	16
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15 — 16	15 — 16	15 3/16	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	125 —130	125 —130	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	*nil*	11 — 12	11 — 12	11⅛	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14 — 15	14 — 15	...	...
220,000	Do. 4½% Deb. Stock, Prov. Certs (£60% to be paid) Rd.	...	...	...	...	54 — 56	54 — 56	54	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	5 %	...	5½— 5⅝	5½— 5⅝	...	...
19,661	House-to-House Electric Light Supply, Ord., 101 to 19,661	5	...	4 %	6 %	8 — 9	8 — 9	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	...	9 — 10	9 — 10	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3½— 3¾	3⅝— 4⅛	4 1/16	3⅝
48,050	Do. do. do. 6 % Pref.	5	...	...	6 %	6½— 7	6⅝— 7	6⅝	6 1/16
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	106 —108	106 —108	...	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	5 %	16½— 17½	16½— 17½	17 1/16	16⅝
22,500	Do. Nos. 62,501 to 85,000	10	...	...	...	15½— 16½	15½— 16½	...	...
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½%	4½%	...	118 —121	118 —121	...	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	6 %	16½— 17½	16 — 17	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½%	14½%	14½%	17 — 18	17 — 18	17⅝	17⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	9¼	...
65,000	South London Electricity Supply, Ord., £4 paid	5	...	...	...	4⅛— 4⅜	4⅛— 4⅜	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	9 %	12 %	12 %	14½— 15½	14½— 15½	15 3/16	15⅛

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation May 24th.	Closing Quotation May 31st.	Business done during week ended May 31st, 1899. Highest	Lowest
60,000	Aluminium "A" shares, Nos. 1—60,000	1	10 %	10 %	...	3 — 3½	3 — 3½	3⅜	3¼
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	95 —100	95 —100	...	...
30,000	British Electric Traction	10	...	...	6 %	18 — 19	18½— 19½	19¼	18¾
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13⅜— 14⅜	13⅜— 14⅜	14¼	14⅛
20,000	Do. do. do. Nos. 40,001—60,000	10	...	...	...	13½— 14	13½— 14	13⅞	13 9/16
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	126 —129	127 —130	129	128½
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	*nil*	*nil*	...	1⅞— 2⅛	1⅞— 2⅛	2	1 15/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	*nil*	4 %	...	2¼— 2½	2¼— 2½	2 7/16	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	103 —106	105	104
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	10 %	12½ %	...	12⅜— 13¼	13 — 14	13⅝	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	114 —117	114 —117	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	11 — 11½	10¾— 11¼	11⅜	11 1/16
178,303	Do. do. do. £8 paid	10	...	...	...	9 — 9¼	8¾— 9¼	9¼	9
61,033	Do. do. Pref. half-shares £3 paid ...	...	...	...	...	3¼— 3⅜	3¼— 3⅜	...	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	5⅜— 6¼	5⅜— 6¼	6	5⅞
630,000*l*	City and South London Railway	Stock	1 1/16 %	1⅞ %	2⅛ %	68 — 70	68 — 70	69½	68
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £5 pd.	10	...	...	...	4⅜— 5¼	4⅜— 5¼	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	3¾— 4¼	3¾— 4¼	...	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	98 —101	98 — 101	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5½ %	6 %	...	2 — 2½	2 — 2½	2¼	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5½ %	6 %	...	4 — 5	4 — 5	...	...
344,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	96 — 98	96 — 98	96½	...
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2¼— 2½	2¼— 2½	2 7/16	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	3 — 3½	3 — 3½	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —106	103 —106	105	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅝— ⅞	⅝— ⅞	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 12	10 — 12	...	...
15,000	Henley's (W. T.) Telegraph Works, Ord.	10	10 %	12 %	14 %	25 — 26	25 — 26	26	25
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18 — 20	18 — 20	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %	4½ %	...	112 —115	112 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21 — 22	21 — 22	21⅞	21 7/16
800,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	101 —105	101 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞ %	3¼ %	3¼ %	8⅝— 8⅞	8⅝— 8⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	14⅝— 14⅞	14 — 14½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	37 — 41	37 — 41	40	38¾
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	105 —108	105 —108	...	...
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	9¾— 10½	9¾— 10½	9 13/16	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5⅝— 6¼	5⅝— 6¼	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	107 —110	105 —108	...	...

† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10⅛.
British Aluminium, Ordinary, 10½—11; 7 % Pref., 12—13.
House-to-House, 4½% Debentures of £100, 105—108.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6%, £5 (fully paid), 7½—8½. Debentures, 107—110. Dividend, 1898, on Ordinary Shares 10%.

National Electric Free Wiring, 10s. paid, 6s.—8s.
Smithfield Market Electric, 3—4.
*T. Parker, £10 (fully paid), 16.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (February 2nd, 1899).

MARKET QUOTATIONS, Wednesday, May 31st.

CHEMICALS, &c.		This week.	Last week.	Increase.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a " Nitric	per cwt.	22/-	22/-	..
a " Oxalic	per cwt.	32/-	32/-	..
a " Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	37/-	37/-	..
a Ammonia, Muriate (crystal) ..	per ton	£26	£26	..
a " " " ..	per ton	£24	£24	..
a Bleaching powder	per ton	£5 15	£5 15	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£16 10	£16 10	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a " (50/90 %)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£26 15	£26 15	..
a Lead, Nitrate	per ton	£23 10	£23 10	..
a " White Sugar	per ton	£30 10	£30 10	..
a " Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.)	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks ..	per lb.	3¾d.	3¾d.	..
a " Caustic (75/80 %) ..	per ton	£24	£24	..
a " Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	68/-	68/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 15	£6 15	..
a " Recovered	per ton	£5 15	£5 15	..
a " Lump	per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 %) ..	per ton	£7 10	£7 10	..
a " Crystals	per ton	£3	£3	..
a " Bichromate, casks ..	per lb.	3d.	3d.	..
METALS, &c.				
b Aluminium Wire, in ton lots ..	per ton	£224	£224	..
b " Sheet, in ton lots ..	per ton	£191	£191	..
p Babbitt's metal ingots	per ton	£65 to £137	£65 to £137	..
c Brass (rolled metal 2" to 12") basis	per lb.	8½d.	8½d.	..
c " Tube (brazed)	per lb.	10½d.	10½d.	..
c " Wire, basis	per lb.	8½d.	8½d.	..

METALS, &c. (*continued*).		This week.	Last week.	Increase or Decrease.
f Ebonite Rod	per lb.	3/-	3/-	..
f " Sheet	per lb.	5/-	5/-	..
g Copper Bars	per ton	£80	£80	..
g " Wire (basis price) ..	per lb.	10½d.	10½d.	..
g " Sheet	per ton	£90	£90	..
g " Rod	per ton	£80	£80	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha, fine	per lb.	6/-	6/-	..
h India-rubber, Para fine ..	per lb.	4/1½	4/1½	½d. dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i " Pig (Cleveland warrants)	per ton	59/5	55/11	3/6 inc.
i " Forgings, according to size	per ton	From £11	From £11	..
i " Scrap, heavy	per ton	50/- to 55/-	50/- to 55/-	..
i " Wire galvanised No. 8 ..	per ton	£10 7 6	£10 2 6	5/- inc.
g Lead, English Ingot	per ton	£14 12 6	£14 12 6	..
g " " Sheet	per ton	£15 7 6	£15 7 6	..
l Mica (uncut slabs 8" long) ..	per lb.	6/8	6/8	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bottle	£8 5	£8 5	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/4	1/1 to 1/4	..
p rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p " r'l'd strip & sheet	per lb.	From 1/2½	From 1/2½	..
o Platinum	per oz.	£3 10	£3 10	..
p Silicium Bronze Wire	per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n	p. ton	to £40	From £15	..
i Steel, Magnet, in bars		£58	£58	..
g Tin, block	per ton	£115	£115	..
g " foil	per lb.	1/6	1/6	..
n " wire Nos. 1 to 16	per lb.	1/7	1/7	..
p White Anti-friction Metals— "White Ant" brand ..	per ton	£40 to £65	£40 to £65	..
j Yarns, Cotton, Single 10lb. bundles	pr lb.	7½d.	7½d.	..
j " Best Flax, 6 lea. ..	per lb.	4½d.	4½d.	..
j " Hemp, 3 ply 10 lbs. ..	per lb.	3½d.	3½d.	..
j " " Russian, 10 lbs.	per lb.	4½d.	4½d.	..
j " Jute, 180 lbs. rove ..	per ton	£12	£12	..
j " Manila, 24 thread ..	per ton	£32 10	£32 10	..
k Zinc, Sheet (Vielle Montagne bnd.)	p.t.	£31 10	£31 10	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d
e

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yeo & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
l Messrs. Sanders, Wake & Co.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

MAGNETISM.*

By Prof. JAMES ALFRED EWING, F.R.S., M.I.C.E.

(*Concluded from page* 876.)

The methods by which the permeability and the hysteresis of iron were at first investigated were laborious, even in the hands of people used to physical research. Several inventors have applied themselves to the task of providing simpler means of making such measurements. Having some personal experience—which began earlier than most people's—in this matter of magnetic testing, I have endeavoured to provide apparatus suitable for workshop use. Three of the instruments devised with this object are before you. The first is a hysteresis tester, which has come into extensive use for measuring directly the hysteresis of sheet iron such as is employed in the cores of transformers and dynamo-armatures. The specimen is a little bundle of strips and it is made to revolve between the poles of a permanent magnet which is free to swing upon a knife-edge. At each half turn the magnetism in the specimen, induced by the permanent magnet, is reversed, and this reversal involves hysteresis, which shows itself by making the magnet become deflected over more or less. The amount of the deflection is read off by a pointer on a scale above, and gives a very simple measure of the hysteresis. The second instrument, I call a permeability bridge. It allows tests to be made of the permeability of forged iron or cast-steel in a way that is analogous to the measurement of resistance by Wheatstone's bridge. The specimen is turned in the form of a rod, and is tested against a standard rod of the same size whose permeability has been determined beforehand. What the bridge actually determines is the ratio of the magnetising forces which will produce the same magnetic induction in the two rods, and by making this comparison for several different strengths of magnetising current we have data for drawing the permeability curve for the rod under test. The process performed in this way is immensely simpler than the older method of testing, and it gives the curve as completely as may be desired. But under the impression that something even more rapid and direct would be useful, I lately brought out a third instrument, the magnetic balance, which by, so to say, weighing the attraction between the test bar and a fixed magnet, allows the induction produced by a particular value of the magnetising force to be read directly upon a divided scale.

The various stages in the process of magnetisation, and the character of magnetic hysteresis will be made more intelligible if I show you in action another instrument which I call a magnetic curve tracer, which enables the motion of a small mirror to exhibit magnetic curves upon a screen. The mirror receives two components of motion; it turns horizontally by amounts which are proportional to the magnetising force, and vertically by amounts which are proportional to the magnetic induction in a magnetic circuit of iron which forms part of the machine. Hence a spot of light reflected on the screen from the mirror traces out a curve which shows how the induction changes as the magnetising force is changed. By reversing the magnetising current repeatedly we make the iron go over and over again through a cyclic process of magnetic reversal, with the result that the spot of light traces out a closed curve, showing hysteresis and having all the characteristics of fig. 3. The moving parts of the instrument are made very light, so that I can quicken the process sufficiently to make the path of the spot appear, by persistence of vision, as a continuously luminous curve.

There are many interesting features of the magnetising process on which, if time permitted, we might dwell. Effects of stress and effects of temperature have been very fully examined, with results which, in some particulars, are of practical import. One point which deserves special notice, on account mainly of its physical interest, is that when we change the state of a piece of iron that is being magnetised, whether by heating or cooling, or by pulling, or pushing, or twisting, or vibrating it, the first effect of the change in temperature, or in stress, is to reveal a certain instability in the magnetism, and it is only after several repetitions of the change of state that things settle down, and the proper effect of the alteration in condition exhibits itself. This is a phenomenon closely associated with hysteresis, and we shall see presently that the molecular theory which explains hysteresis explains it also.

The effects of temperature on magnetic quality have a direct bearing on some of the engineering applications of magnetism. Some of those effects are immediate, and some only show themselves when the iron has been heated for a considerable time. The immediate effects of heating were examined by Hopkinson, and more lately they have been the subject of an excellent investigation by Mr. D. K. Morris. Briefly, the general effect of heating is to increase the permeability and reduce the hysteresis of iron until a certain critical temperature—about 780° C.—is reached, when iron loses nearly all its power of being magnetised. The change happens somewhat suddenly, for at temperatures only a little lower than that the permeability is very great and the hysteresis exceedingly small. The curve, fig. 8, taken from Mr. Morris's paper, shows how the maximum permeability alters as iron is heated. There is a general rise in permeability, subject, however, to several set-backs in the course of the rise. The first of these happens about 250° C., the next between 400° C. and 500° C., and the greatest about 760° C. Now compare this with the curve shown in fig. 9, which represents one of Sir W. Roberts-Austen's beautiful investigations of the rate at which a piece of iron cools from a white heat. There is a steady fall of temperature except at certain places where some internal convulsion happens which is associated with the giving out of heat. Note the points where this occurs, and you see that they connect themselves with what I have called the set-backs in the other curve. We may even trace a connection between the highest of these breaks and a change which is slightly apparent in Morris's curve about 900° C, though the iron then retains very little magnetic quality at all. The inference seems pretty plain that not only at the great magnetic critical point is there a transformation of structure associated with absorption of heat during the heating of the iron, but that a similar connection holds at the other points of arrest.

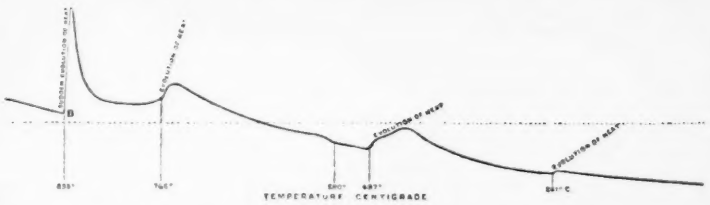


Fig. 9.—Record of the Cooling of Iron (Roberts-Austen).

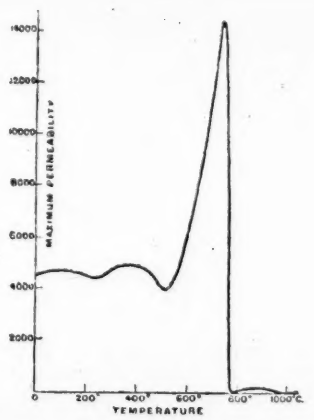


Fig. 8.—Effects of Temperature on the Permeability of Iron (Morris).

But it is with the effects of long-continued heating that engineers are more concerned. It was observed that transformers lost some of their efficiency after they had been kept at work for some weeks or months, and that this was due to an increase of hysteresis in the iron core. Mr. Mordey proved that this increase of hysteresis resulted from the prolonged baking of the iron; a transformer at work becomes warm, largely because of the heat developed through hysteresis, and long exposure to a somewhat high temperature gradually alters the iron for the worse. The amount of this deterioration depends much on the degree of heat, and it is by no means the same for all specimens of iron; sometimes iron which is at first particularly free of hysteresis is most affected. Mr. Roget, who has investigated the matter in my laboratory, has found that continuous exposure for seven days to a temperature of only 160° C. has actually trebled the hysteresis of one very good specimen; but, what is most curious, a further continuation of the baking at the same temperature causes improvement to set in. The hysteresis

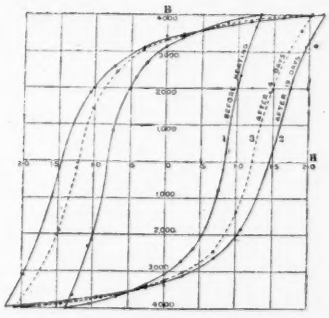


Fig. 10.—Effects of Baking of the Hysteresis of Sheet Iron (Roget).

* Institution of Civil Engineers, James Forrest lecture.

passes a maximum, which comes earlier the higher the temperature of the baking, and then tends to lessen when the baking is further prolonged. The curves, figs. 10 and 11, relate to a ring of sheet-iron heated at 200° C., and show the kind of change which happens, as well as how the changes in hysteresis are associated with corresponding changes in the permeability of the iron. At that temperature the maximum is passed after a comparatively short period of baking.

This augmentation of hysteresis is a serious matter in transformers, and much attention has been given to getting iron which will not show it. Some specimens were lately submitted to me which were not only extraordinarily free from this objectionable characteristic, but had much less hysteresis even initially than

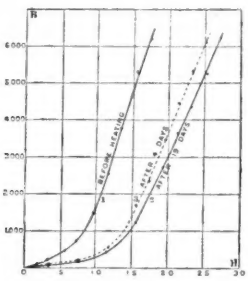


Fig. 11.—Effects of Baking on the Permeability of Sheet Iron (Roget).

any iron I had tested before. Makers are naturally reticent as to the processes of manufacture by which such results are obtained, and they have in some cases an additional and excellent reason for reticence in the fact that they really do not know what the conditions are to which the good results are to be ascribed. It is probable that light will be thrown on these difficult questions by the application of the microscope, a tool the value of which the metallurgist is now fast coming to recognise.

Much that is obscure in the phenomena of magnetisation is made plain when we come to consider the molecular theory of the process. It is an old idea, due originally to Weber, that the molecules of iron are always magnets, and the process of magnetising a piece of iron is merely to turn the molecular magnets round so that they face one way. At first they are pointing every way at random, but when magnetising force is applied they gradually turn, and finally, when saturation is attained they all lie with their magnetic axes exactly along the line of force. To account for their not all turning at once, and also for the fact of residual magnetism, various hypotheses have been framed, as, for instance, that the turning of each molecule is resisted by what may be described as a miniature friction-brake. A good deal of meditation on this matter led me to the conclusion that no such hypothesis was needed. The gradual turning of the molecular magnets and all the phenomena of hysteresis are simply results of the mutual actions between each molecule and its neighbours. We may demonstrate this by means of a model consisting of a large number of permanently magnetised needles set on pivots near together. When a weak magnetic field is applied the pivoted magnets turn slightly and in a quasi-elastic manner, free from hysteresis; but as the field is strengthened the ties between them are overcome and instability ensues, the original groups break up, and the magnets enter into new combinations. Finally, as the applied field becomes stronger still, complete parallelism is gradually approached.

Thus the model reproduces with perfect fidelity what I have called the three stages of the magnetising process. Moreover, the dissipation of energy involved in the breaking up of molecular combinations corresponds exactly to what we know of hysteresis. The model shows not only how this cause of hysteresis affects a cyclic process of magnetisation, but how it explains the instability which I mentioned as the first thing noticed when we heat, or cool, or stress a piece that is being magnetised. Any change of condition precipitates the breaking up of groups which were, so to speak, hesitating on the verge. By using a model with a large number of little magnets we get the aggregate external magnetic effect of the group to vary with variations of the field exactly in the way in which the magnetism of iron varies, and the model indicates not only the main, but even the minor features of the process. It was pointed out by Mr. James Swinburne that my theory would involve this curious result, that a piece of iron when revolved in a very strong magnetic field would exhibit no hysteresis, though it shows much hysteresis when revolved in a weaker field. The prediction was experimentally verified by Prof. Baily. We may illustrate this in the model by turning round the plate which carries the little pivoted magnets, when you will notice that breakings up of molecular groups occur when the field is weak, but not when the field is strong.

I think this model has a bearing on other physical matters which concern engineers. It is easy to believe that between the molecules of materials there are other polar forces acting, distinct from magnetic forces, and common to non-magnetic as well as magnetic materials. When we make one body slide on another, these intermolecular forces acting across the surface of contact may cause the molecular groups near the surface to become broken up and reconstituted, thereby giving rise to the dissipation of energy, which we are familiar with under the name of friction. The action will be apparent if we make one group of the little pivoted magnets slide past another group. We may go further and say that all non-elastic deformation of solid bodies by strain is probably an action of the same kind. Experiments which I have lately carried out, in conjunction with Mr. W. Rosenhain, have shown that the plastic straining of metals occurs through a multitude of separate slippings of one part on another, in each of the crystalline grains of which the metal is made up. The model may be taken as illustrating how, with molecules possessed of polar forces, such slips involve an expenditure of work. But this is taking me away from my already too comprehensive text.

I have tried in this hurried sketch of a great subject to show how in some cases invention has followed as the fruit of discovery, while in others discovery has resulted from the interest created by invention. One word in closing to the student of research. Do not think that in magnetism, because much has been done, nothing is left to do. The upper workings of the mine may be exhausted, but there are deep levels whose wealth is unexplored. Every point gained is a starting ground for fresh inquiry. The patient and intelligent worker may rest assured that his labours will find a return, not perhaps in profit or in fame, but in that pure impersonal joy of discovery which, as those who have tasted it know, is the investigator's best reward.

CONSULTING ENGINEERS.

In a recent number of the *Engineer* reference was made to the evil of the English system of bridge construction through the intermediary of the consulting engineer of the accepted type. The *Engineer* describes how the great man has never set foot in a steel works, and is absolutely ignorant of standard sections; how the young fellows in his office calculate the stresses and so on, and how finally a bridge is designed, of which there is no portion that has not to be specially made, and no portion that will be repeated in any other bridge. Special sections will be rolled, for which, of course, special rolls must be turned. Even plate thicknesses will be specified to the hundreth of an inch. The whole work will then be rigidly specified and inspected. Things are managed very differently in America. The consulting engineer, as we know him, does not exist, that is, he is not supposed to get out designs in detail, but he will draw up a general specification and call for tenders, and will see to it that the tenderers offer something which fills the spirit of the specification.

In bridge work, for example, a branch of engineering which has been lately brought forward prominently by the Atbara Bridge contract, there are a number of bridge specialists in the United States, men like Theodore Cooper, who publish their own standard specifications, but not one of these men designs a bridge except he has before him the pocket-books of the various rolling mills. These section books of the American rolling mills are in themselves perfect treatises on bridge building. Some of them are so far perfect that by their aid men who cannot calculate stresses can get out a safe bridge without serious loss of economy.

No American bridge specialist gets out a design which cannot be filled by the ordinary run of the mill. As bridge requirements grow new sections are called for from time to time, but when a new roll is turned it is because it is wanted, and the section is put into the next edition of the pocket-books and will be repeatedly used afterwards. The rolls will not be wasted. No English rolling mill gets out a section sheet worthy of the name, and we have no hesitation in saying that any engineer abroad who had an American mill pocket-book would use it in his design, and the bridge he designed would obviously demand American sections to make it. These American section books give every dimension, and the extreme limits of thickness to which it can be rolled. They give the moments of inertia of each section for use as columns. They give the allowable unit stresses on columns of different lengths and the safe bearing and shearing stresses for plates and rivets.

The real bridge specialists in America are the builders. Each builder may favour his own particular design, but even here there is probably less diversity than will be found in two bridges out of the same Westminster office to carry the same train over the same canal at the same span and with the same conditions of headway.

No doubt the engineer's pupils are found work to do on two designs in place of one, and the community pays for it. Nero fiddles while Rome burns.

The one point in the American system where money is wasted is that perhaps a dozen firms submit tenders and drawings and send a representative to be present when bids are opened, and thus each bridge may be really designed 12 times over; but even here the expense is not so great as at first sight appears. Often the preparation of the design may mean little more than writing out a title to a drawing and printing off a standard drawing as a blue print. The *American Machinist* comments on the article in the *Engineer* we have referred to, and points out that the fault of the English system is the misuse of the consulting engineer as a designer. A consulting engineer cannot be a specialist on everything which comes under his supervision, but he may have the knowledge of principles and general practice which will enable him to select the best design offered and to advise generally.

At present, however, there seems to be some little difficulty in this respect, and engineers who really wish to do the very best possible for their clients would do well to have a special agreement beforehand that they are not bound to design the whole of the plant and machinery of a concern they may be called in to construct. In a recent instance an engineer was employed to get out plans for a new process. The undertakers were not technical men and had no ideas beyond the small experimental plant they already possessed, and were

of opinion that this only needed to be extended on the same lines. The engineer soon found that this plant was wasteful and dangerous and wholly unsuited for continued use, and he found also that to construct the plant and buildings would cost much more than to employ standard machinery. He therefore recommended that an entire departure should be made from the experimental plant, and this was with difficulty accepted, and the plant laid down at an economy of about 30 per cent. upon the designs favoured by his clients, and which would have been absolutely useless. When it came to payment of fees these men refused to pay on the ground that having employed to a large extent standard machinery, the engineer was not entitled to his full fees, and rightly or wrongly the engineer's own counsel, an eminent Q.C., upheld this view as law if not as moral. In saving his clients about £3,000, the engineer was robbed out of several hundred pounds. If the Q.C. was right, it is time that the law should be altered, for at present there is no inducement for an engineer to economise on behalf of his clients, for if he do he may render himself liable to lose all his payment. It is a rotten system altogether that enables unprincipled clients to shirk payment, and one which cannot have other than an evil effect on British trade. Engineers who would practice on the American system of doing the best possible for their clients by utilising standard productions in place of re-designing articles in which they are not themselves the best specialists, should, therefore, be careful that they are protected against such conduct as we have detailed. Unfortunately, we find that contractors who may benefit by the engineer's action are not always too careful of the engineer's interest, and will go behind his back if they think they can thereby find favour with his wealthier clients.

In face of the tremendous pressure from the foreigner, we think it would be well if some kind of recognised procedure could be drawn up by the various engineering institutions as a guide and protection, and something might be done in the way of providing means to carry cases to the courts. It is not every engineer who can carry a case into the law courts and fight a soulless corporation, and we are persuaded that much injury is done by syndicates and others to engineers in this very way which would not be done if it were known that they had not merely an individual to fight.

ON THE LUMINOSITY OF THE RARE EARTHS WHEN HEATED "IN VACUO" BY MEANS OF CATHODE RAYS.*

By A. A. CAMPBELL SWINTON. Communicated by LORD KELVIN, F.R.S.

For incandescent gas mantles it is found that certain definite mixtures of the rare earths are necessary in order to obtain the maximum luminosity. For instance, in the ordinary Bunsen gas flame, a mantle consisting of pure thorium oxide or of pure cerium oxide, will only give about $\frac{1}{4}$th of the light that is given by a mantle composed of 99 per cent. of thorium oxide and 1 per cent. of cerium oxide, which is the mixture at present used by the Welsbach Company.

In order to explain this remarkable fact, several different and somewhat contradictory theories have been propounded, one of which implies catalytic or other chemical action between the oxides and the constituents of the Bunsen flame.

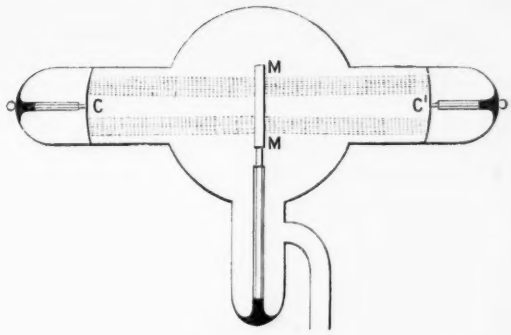
In order to investigate this question, it is obviously important to note the behaviour of the rare earths at high temperatures without contact with any flame, and endeavours have already been made to effect this by heating the oxides in specially constructed furnaces. Under these conditions, only very minute differences could be detected in the amount of light given by different oxides and mixtures, but it appears doubtful whether the very high temperature of the Bunsen flame was really attained.

It has occurred to the writer, that very high incandescence could be produced by enclosing mantles in a vacuum tube, and subjecting them to bombardment by means of cathode rays, when the mantles would not be in contact with anything except the cathode rays themselves, and the comparatively small amount of residual gas that remains in the tube at the requisite high degree of exhaustion.

Since the date of Sir William Crookes's early researches, it has been known that a very high temperature could be produced in a body placed at the focus of the convergent rays from a concave cathode. In this manner Crookes melted platinum and glass, and brought carbon wool to bright incandescence. The writer has made many experiments on this subject, using instead of the interrupted continuous currents employed by previous investigators alternating electric currents, which appear to have many advantages for this purpose. At the Royal Institution, in February, 1898, the writer showed that very brilliant incandescence could be obtained for a short time in a small block of lime, placed in a suitably exhausted tube midway between two concave electrodes, connected to an alternating electric supply at about 6,000 volts pressure, and in June, 1898, at the Royal Society, he exhibited in action a similar arrangement, but with the block of lime replaced by a flat plate of thorium oxide. In this case the concave electrodes were of such a curvature and were placed so far apart, that the two sides of the thorium plate in each case intersected the diverging cone of cathode rays. Under these conditions nearly a square inch of the thoria surface on each side of the plate became highly incandescent, and a very powerful light was obtained for some minutes at a time, but only at a critical and highly unstable degree of vacuum.

The writer has now applied this method to the investigation of the comparative luminosity of different mixtures of the rare earths.

One form of the tube employed was constructed as shown in fig. 1, where C, C′ are two spherically concave discs of aluminium 1·125 inches diameter and 6 inches radius of curvature. These electrodes are placed about 7 inches apart, and were connected to the secondary



terminals of a 10-inch Ruhmkorff coil, the primary of which was supplied through a variable resistance, with alternating electric current at 100 volts pressure from the main. The tube was connected through a drying tube containing phosphorous pentoxide to a pair of Toepler pumps, and also to a McLeod gauge.

The mantle, M M, to be experimented upon was mounted on a platinum wire frame, and placed between the two electrodes, so that as the electric current alternated, and each electrode became in turn cathode, the mantle was subjected on alternate sides to cathode ray bombardment. The curvature of the electrodes was such as to give almost parallel beams of cathode rays, so that a considerable ring shaped and slightly hollow area on each side of the mantle was subjected to the rays, and could be brought to high incandescence.

A preliminary experiment was made with a mantle of asbestos, powdered over in patches with pure thorium oxide. With this it was found that at a suitable degree of exhaustion, the patches of thoria became brilliantly incandescent, with an intensity of cathode rays that made the asbestos barely red hot.

Experiments were next made with mantles consisting entirely of thoria and ceria, both separately, and mixed in different proportions. These mantle were prepared in a similar manner to the Welsbach incandescent gas mantles, by saturating a carefully purified cotton fabric with ammonium nitrate of thorium and cerium, and then burning out the cotton. Very thick and closely woven cotton lamp wick, freed from foreign matter by treatment with caustic soda, hydrochloric acid, and ammonia, was employed in place of the thin fabric usually used, so that the resulting mantle, after burning out the cotton, was very close in texture, and fully 0·2 inch thick. This was found necessary, as otherwise some of the cathode rays passed through the mantle and melted the opposite aluminium electrode.

In order to obtain accurate comparisons between pure oxides and different mixtures, the mantles were made in patchwork, each complete mantle being made up of two or four sections, separately impregnated with different solutions, and then sewn together with impregnated cotton before being burnt.

The mantles were so mounted in the vacuum tube that the cathode rays impinged equally upon the portions that consisted of different mixtures, so that an equal amount of energy was imparted to each sample.

With a compound mantle prepared in this way, composed one-half of pure thorium oxide, and the other half of a mixture of 99 per cent. thorium oxide plus 1 per cent. of cerium oxide, it was found after exhaustion that on starting the cathode discharge the thoria plus ceria heated up to incandescence more rapidly, and on stopping the discharge, cooled more rapidly than the pure thoria. Further, when at full incandescence, and observed through a dark glass, the thoria plus ceria was slightly more luminous than the pure thoria, though the difference was very small—probably not more than 5 per cent. Owing to the difficulty of maintaining a constant vacuum, accurate photometrical measurements were not possible, but the amount of light under favourable conditions was roughly estimated at, at least, 150 candle-power per square inch of incandescent surface, this being obtained with an expenditure of electrical energy in the secondary circuit at about 8,000 volts pressure of approximately 1 watt per candle. The amount of exhaustion suited to give the best results varied with the dimensions of the tube and the conditions mentioned below, but was approximately about 0·00005 atmosphere, the maximum luminosity being obtained when the dark spaces of the two cathodes just crossed at the centre of the bulb. Owing to the large amount of gas occluded by the mantle, a proper degree of permanent exhaustion was very difficult to arrive at, and required continuous pumping for many hours with the cathode rays turned on at intervals. Even then the conditions of maximum luminosity were exceedingly unstable, owing to the further liberation of occluded gas on the one hand, and on the other to the rapid increase in the degree of exhaustion owing to absorption of the residual gas by the electrodes. That such absorption probably took place in the aluminium electrodes, and not in the mantle, was demonstrated by other experiments with a

* Royal Society. Received March 20th, read April 27th, 1899.

tube in which there was no mantle, but only two electrodes of aluminium wire.

After the cathode rays had been allowed to bombard the mantle for a short time, the latter was found to have become discoloured where bombarded. That portion which was composed of pure thoria became dark blue, while the thoria plus ceria became brown. This effect, which appears to be analogous to those observed by Goldstein with lithium chloride and sodium chloride,* seems to be due to a partial reduction of the oxides by the cathode rays. The admission of a very minute quantity of air to the tube while the cathode rays are acting on the mantle, and the latter is in parts incandescent, causes the discolouration to disappear instantaneously on the incandescent but not upon the cool portions, probably by re-oxidation of the partially reduced oxides, while the discolouration also slowly vanishes in a day or two with the mantle cold if air at ordinary atmospheric pressure is admitted to the tube. By continuing to bombard the mantle with cathode rays, and alternately allowing the vacuum to increase and letting in small quantities of air, the discolouration can be made to appear and to disappear over and over again as often as desired. At the moment of admitting the air, the amount of light was found momentarily to increase, this being probably due to the increased temperature due to the re-oxidation of the partially reduced oxides.

After repeating this process of letting in small quantities of air, and allowing them to be absorbed several times, it was found that the degree of exhaustion which gave the maximum incandescence had altered from 0·000047 to 0·000112 atmosphere, as measured by the McLeod gauge. Similar effects were obtained with a tube containing no mantle, but only aluminium wire electrodes, the inference being that some change takes place in the residual gas which renders it less conducting.

At a higher degree of exhaustion than that which produced incandescence of the mantle, the pure thoria was found to fluoresce blue, and the thoria plus ceria with a yellowish light. The fluorescence in each case was much less bright when the oxides were white than when they had become discoloured by previous bombardment. With very high exhaustions the thoria plus ceria fluoresced the more brightly; at lower exhaustions the pure thoria gave the brighter fluorescence.

On the suggestion of Mr. W. Mackean, the tube was pumped up to a very high vacuum and oxygen admitted. A similar experiment was made with hydrogen, the tube being completely filled with the gas, and then pumped to the proper degree of exhaustion. Though at low exhaustions these gases gave distinctive appearances to the discharge in the tube, no difference in the behaviour of the mantles with them and with air could be detected when once the vacuum reached the degree required for producing incandescence of the mantle.

Further experiments were made with a similar tube containing a compound mantle made up of four sections, composed as follows:—(1) pure ceria, (2) pure thoria, (3) 50 per cent. thoria 50 per cent. ceria, (4) 99 per cent. thoria 1 per cent. ceria.

With an intensity of cathode rays that gave a brilliant light with Nos. 2 and 4, Nos. 1 and 3 were found to give practically no light, becoming barely red hot; while, as before, No. 4 was found to give slightly more light than No. 2, and to heat up more rapidly and cool more rapidly than the latter.

These experiments show that thoria and ceria, both alone and mixed, behave quite differently when heated by cathode ray bombardment than when heated in a Bunsen flame. In the latter 99 per cent. thoria, plus 1 per cent. ceria, gives many times as much light as pure thoria alone, while, when incandesced by cathode rays of equal intensity, the difference, though in a similar direction, is exceedingly small. Again, in the flame, pure ceria gives just about the same amount of light as pure thoria, while with a given intensity of cathode ray bombardment, thoria gives a brilliant light, while ceria gives practically none.

In arriving at any finally satisfactory theory of the luminescent properties of the rare earths, these results with cathode rays, which differ materially from those obtained by other methods of heating, will require to be taken into account.

I am indebted to the courtesy of the Welsbach Incandescent Gas Light Company for the samples of the rare earths with which the above investigations were made; also to the assistance of Mr. J. C. M. Stanton and Mr. H. Tyson Wolff in carrying out the experiments.

* *Wied. Ann.*, 1895, No. 54, p. 371.

FURTHER NOTES ON THE PESCETTO ACCUMULATOR.

[CONTRIBUTED.]

This accumulator is claimed as being the accumulator *par excellence* of the light type. Its efficiency in energy keeps high (70 or 80 per cent.), even when the element is subjected to a high rate of charge (20 amperes per kg. of plates), *i.e.*, even when the duration of the charge is reduced to a few minutes, with a rate of discharge varying from the normal rate (2 amperes) to 5 or more amperes per kg. of plates. The efficiency in quantity, *i.e.*, in ampere-hours is always very high and sometimes attains to 98 per cent.

This important advantage of the Pescetto accumulator is not obtained as might be supposed to the detriment of its duration: it is attributable to the small amount of internal resistance due to the *excellence of the electrical contacts and to the great permeability* offered by the positive and negative active material to the charge reactions. The excellence of the electrical contacts is obtained by a special mode of preparation of the plates, which are composed of an alloy of lead and antimony amalgamated with a certain quantity of mercury. The plate thus obtained is then prepared mechanically so as to subdivide the active material into quite little centres, and to keep them firm so as to avoid their fall. In this manner the charging current provokes the electrolytic action of the bath over the whole available surface of the electrodes in a uniform manner.

The permeability of the active material is obtained by adding to the heavy oxides a certain quantity of ulmate of ulmine produced in microscopic grains, which are distributed by kneading into every part of the paste and which absorb and keep till the final reaction eight times their volume of the gases produced by the electrolysis. The best mode of convincing oneself of the truth of the above description is to subject one of our elements to the charge at a constant potential. The high intensity of the current shows the great diminution of internal resistance, whereas the long duration of this current shows that the active material absorbs the gases produced by the electrolysis, and that the reaction is thorough. The complete stillness of the liquid shows that the reaction is not forced.

A comparison between this accumulator and the types already in use is shown by one of the Pescetto elements performing at Rome the same service as that performed at Paris by a Tudor element on the Madeleine-Courbevoie line. The weight of the car, speed, and nature of the line being the same, the Tudor battery on the Paris line weighs 3,600 kg., and has been admitted to be inadequate, whereas the Pescetto battery at Rome, which has never met with the slightest hitch, does not weigh 2,000 kg.

In order to show still further the advantages of the Pescetto accumulator we will quote the result of the last experiments of engineer Hauswald on one of the Frankfort lines worked with Pollak accumulators.

The consumption of energy per ton and per kg.,* which was 60 watt-hours with the trolleys fell to 40 and 30 watt-hours with accumulator traction either owing to the suppression of the sudden variations of charge that occur on the wires of overhead lines, and consequently to the suppression of sudden variations of tension at the motors, or owing to the suppression of the great losses caused by sparks between the trolley and the wire and between the wheels and the rails. This economy of energy will be still greater with an accumulator capable, like the Pescetto accumulator, of being rapidly charged between each journey, for the batteries, when saturated, give a higher efficiency of energy with less consumption, which renders their maintenance more economical.

With the best accumulators now in use, the increase of the weight of the car due to the accumulators is about 25 per cent., whereas, with the Pescetto system, this increase is only 14 per cent., and may be still further reduced for lines with only slight inclines and without sharp curves.

The following report is of interest:—

The Tramways and Omnibus Société Romaine, Rome.

The Societa Italiana di Elettricita gia Cruto, Turin (which is working the Pescetto accumulator).

At your request we are pleased to express our satisfaction at the working of the batteries of accumulators supplied by you for transforming our horse tramways into electric traction lines, to be worked either by accumulators alone or by a mixed system.

We inform you therefore:—

1. That your batteries of 204 elements, weighing about 2 tons, are adequate for the working of our lines.

2. That the duration of the charge for the Ripetta line, which is worked exclusively by accumulators, has never exceeded 4 minutes.

3. That during these first three months of working the above line, no hitch has occurred.

4. That having by contract the right of controlling the expenses of maintenance taken up by you, we found for these three months for the six Ripetta batteries that only 12 plates had to be replaced, and that this was owing to a fault in their mounting.

5. That the mean consumption of energy per car kilometre taken from measurements which are not yet final, made on the Ripetta line, is about 600 watt-hours.

We are about to take fresh measurements in order to note the excess of consumption due to the provisional use of the Thomson motors constructed for the trolley lines (*i.e.*, for working at a potential of 525 volts, whereas the potential at the battery is about 400 volts) and also due to the employment of regulators with metallic resistances instead of regulators based on the principle of grouping in parallel two half batteries or two quarter batteries.

We take this opportunity of expressing our satisfaction at having adopted the Pescetto type, which we consider superior to those at present in use.

(Signed) The President, L. Cavallini.

* Per ton kilometre?—Eds. Elec. Rev.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Electric Locomotives.

The meeting of the Institution of Electrical Engineers on Thursday, 18th ult., at the Society of Arts, was occupied with a discussion of Mr. P. V. McMahon's paper on "Electric Locomotives." To save time, and also to assist the members to take part in the discussion, Mr. McMahon presented and read a summary of the contents of his paper.

The discussion was opened by Mr. Grove, who expressed his indebtedness to the author, feelingly remarking that, as the designer of one of the locomotives tested, he could appreciate the enormous value of the paper. He felt that the author was on solid ground, eminently his own, when dealing with facts, but when explanations were given or broad theories stated, the result was not quite so happy. Mr. Grove did not find the question of drawbar pull treated sufficiently precisely. To illustrate this, he referred to a number of statements in the paper where the force at the tread of a motor wheel was given, and thought that this could not be treated—as it seemed to be—as drawbar pull. The argument was gone into at some length, and although highly interesting to those who had the paper thoroughly in their minds, we are sure our readers will prefer to compare the authorised report of the discussion with the paper rather than have the argument taken up in detail here.

Another point raised was the comparison between the measurements of drawbar pull and the tests of motors under statical conditions. Mr. Grove believed that a simple torque test had a great superiority over a Prony brake test, and described a method he had used in practice. When statical torque was measured that way it was a purely current function of the magnetic flux. Knowing that value, then, from the E.M.F. equation, a speed curve could be found more accurately than by tachometer measurements, and the results justified the harmony between theory and practice. He was surprised that any accurate results could be obtained by simultaneous, or approximately simultaneous, readings of current and speed when the time was given by an observer with a whistle, the difficulty was to arrive at the actual instantaneous speed of the locomotive. Three years ago he had made tests with a dynamometer car on the Inner Circle line, but found it very difficult to get the actual speed of the train. He suggested that if the author could see his way to put in an apparatus to record results something might be gained.

Mr. Taylor had some three years ago taken up the question of tractive resistance per ton of train, he had worked out the resistance per ton on the level, but his results differed materially from the author's. Mr. Taylor exhibited a set of curves illustrating his contribution to the discussion, these called forth the remark from Prof. Perry that they were very different curves to anything anybody had published before.

Mr. Crompton, although invited to speak, preferred the more leisurely method of contributing to the *Journal*. Thereupon Mr. Mordey congratulated the author upon the mass of practical results and the perseverance displayed in obtaining them. He had hoped they would have been criticised by our American friends, who had much more experience than anyone in this country. When in the United States he was told that the controller really controls everything. It was, therefore, interesting to note that the author used a controller not at all like those used in the United States in traction work. Mr. Mordey thought the explanation was that the author switched off his current while the motors were at full speed. In tramway work the current was usually switched off while there was little or no counter E.M.F. in the motors. Perhaps all who had practical experience knew the difference between breaking the circuit of a motor and of a generator at full speed. In the case of the generator the E.M.F. tended to prolong the current. The paper reminded him of a monkey which had got a nutshell too hard to crack, but it was worth some labour to get at the very excellent results the paper undoubtedly contained.

Mr. R. P. Brousson referred to the series-parallel method of control, and to dynamometer tests on Central London Railway locomotives. The present practice was to increase acceleration very much, and this could be done without the passengers being inconvenienced. He noted that the author had not found it necessary to lock the reversing switch, but he thought that as the reversing switch is most needed when a man was likely to lose his head, it should be locked.

Prof. R. H. Smith found no time for any proper tribute of admiration for the amount of work in the paper which was represented not merely by experiments, but also by the exhaustive calculations based upon observations at five-second intervals. He advocated observations at very frequent intervals in investigating this subject. Naturally Prof. Smith was specially interested in the design of the dynamometers, and considered the merit depended upon the adoption of a zero method, or at least the parts must move very little, in order to make such an instrument really successful where shocks could not be avoided. He thought the difficulty of understanding the paper had been increased by vagueness of terminology, and it was unnecessary to let the readers of a paper see the author's mind working through the difficulties before he solved them. He then, at some length, discussed drawbar pull and locomotive losses, basing his remarks upon actual examples in the paper—a rather tedious subject unless the paper be before one.

Prof. Carus-Wilson raised the point of air resistance in tunnels, and wanted the author to give further particulars. He was obliged to the author for attempting to solve part of the problem, the air resistance behind the drawbar, but under the circumstances in the paper we were not told the air resistance experienced by the locomotive itself. He had figured out the ratio of area of car to area of tube at 56 per cent., and would not expect air resistance to be anything serious at speeds such as were used in these experiments. Another interesting point was the author's method of shunting the motor fields. Prof. Carus-Wilson was not aware that this method had been used on a large scale before. Taking the first series of experiments, the author simply proceeded to increase the number of armature turns, and had to shunt the fields to get the speed. The effect was simply to get the characteristic or induction curve more straight than could be got from the simple curve of the motor. He congratulated the author on the success of this method of controlling.

Mr. McMahon in his reply did much to clear up the vagueness, mentioned by several speakers, in the paper about drawbar pull. In starting, experiments were made by testing the motors lying on their backs by the Prony brake, and the 73 per cent. mentioned in the paper was the ratio of the actual pull of the motor lying on its back to the pull on the drawbar with the locomotive at rest and on a level. He did not agree that a better result was obtained from a static test, as suggested by Mr. Grove and others, than with the Prony brake because of friction in the bearings. Five-second readings agree with wonderful accuracy, and in a check trial the distance travelled as calculated agreed within 1 per cent. with the actual distance covered. The locomotives came out very closely with design, and where they differ it was due to the drivers not using current as the author intended. In reply to Mr. Mordey, a driver had occasionally to set back to get a coupling in, the parallel control was not, however, put back until current was cut off. No locking of switches was found necessary. Simplicity in controlling arrangements was one of the first things sought; a man who lost his head and could not get a handle to move was very likely to make it work by bending something. He thought it was rather a pity writers of papers did not lead readers along; they too often rushed into advanced tests without sufficient preliminary description. He had made some air resistance tests by a swing gauge, and found about 2 lbs. per square foot at a speed of 14 miles per hour.

After the President had made some further congratulatory remarks, the meeting adjourned with the intimation that the annual general meeting would be held on the 25th ult.

DR. TOMMASI "ON THE LAW OF THE PROPORTIONALITY OF THE ELECTRO-MOTIVE FORCE OF DECOMPOSITION."

The electro-chemical paper published by Dr. Tommasi in the *Bulletin Technique* under the above title may advantageously be read in conjunction with the paper by the same writer recently published in our columns.*

In the present paper Dr. Tommasi refers to the following statements by M. Minet relative to the "Law of the Proportionality of the Lowest Electromotive Force Necessary to Produce the Decomposition of an Electrolyte, and the Heat of Formation of this Electrolyte":—

* "Relation Between the Heat Given Off Inside Voltaic Couples and the Heat Capable of being Transmitted to the Circuit Under the Form of Chemical Energy," April 7th, 1899, p. 541.

1. "That numerous facts appear to constitute exceptions to this law, which form the subject of noteworthy researches on the part of *savants* such as Joule, Favre, Thomsen, Helmholtz, &c."

2. "That the theory of the voltaic couple, of which the reactions are of the same order as electrolytic reactions, is derived from these researches."

The author of the paper claims that, as early as 1881, he pointed out in various notes presented to the Académie des Sciences a certain number of facts which are exceptions to the above-mentioned law. Dr. Tommasi had, in fact, observed that, in certain cases, not only was the heat evolved by the chemical reaction produced within a voltaic couple not entirely transformed into electricity (electrical energy or work), but the calories transmissible in the circuit in the form of chemical energy varies according to the nature of the positive electrode of the voltaic couple.

We would here observe that by "positive electrode," the author of the paper no doubt means the electrode corresponding to the copper element in a Daniell cell. But this latter is undoubtedly the negative electrode, or *cathode*, within the cell; the zinc element being the *anode* within the cell or the electrode by which the current passes to the electrolyte.

Dr. Tommasi gives, as an example, a chromic acid couple with zinc as the positive element; the weight of chromic acid (H_2 Cr O_4) in contact with the negative element being 25 grammes, and the volume of sulphuric acid (H_2 SO_4) in admixture with the chromic acid being 10 cubic centimetres. Taking the specific gravity of H_2 SO_4 as 1·848, the relative weights of chromic acid and of sulphuric acid in contact with the negative element are thus:—

Twenty-five grammes and $10 \times 1{\cdot}848 = 18{\cdot}48$ grammes. It may be assumed that excess of sulphuric acid, in a diluted condition, is present within the porous pot containing the zinc element.

Dr. Tommasi gives as follows the results of his experiments with this couple:—

"A chromic acid couple, which, according to Favre, should evolve 117·3 calories (2·5 volts) actually produces external chemical work corresponding only to about 65 calories (1·4 volt), or 85 calories (1·8 volt), according as the positive electrode of the couple is platinum or carbon. Moreover, I had observed that the physical condition of the substance constituting the positive electrode exerts a great influence upon the electromotive force of this couple. Thus, if instead of using platinum in the form of plates or wire, we use it in the spongy form, it is found that the E.M.F. of the chromic acid couple is 1·8 volt (85 calories) instead of 1·4 volt (65 calories)."

The matter may be somewhat elucidated, in the first place, by some explanatory observations on the above statement for the benefit of our British readers.

1. The 117·3 calories, and the other calorific values from which voltage is calculated, refer to the heat evolved per dyad gramme equivalent, *i.e.* per 64·9 grammes of zinc, combining with 98 grammes of sulphuric acid, or to the heat evolved, or the work done, by the passage in the circuit of 193,200 coulombs = 53·6 ampere-hours. The calorie which is here taken is not the original gramme-centigrade unit of heat of Dulong, but is 1,000 times greater, *i.e.*, it is really the kilo-calorie.

2. In regard to the calculation of E.M.F. from calorific data, 46 of these calories, per dyad gramme equivalent or per 53·6 ampere-hours, correspond to 1 volt.

3. What Dr. Tommasi terms the "positive electrode of the couple," *i.e.*, the platinum or carbon, is the negative electrode or element, or cathode, within the cell; although it constitutes the positive pole externally, and an electrode attached to it would constitute a positive electrode or anode in a second electrolyte.*

The electro-chemical equation for the chromic acid (zinc) couple is the following, in which, to avoid fractions, we have to take 3 (dyad) equivalents of zinc.

$$3\,Zn + 6\,H_2SO_4 + 2\,H_2CrO_4 = 3\,ZnSO_4 + Cr_2\,3\,SO_4 + 8\,H_2O.$$

Thus, the metal chromium being tried, and 3 H_2 SO_4 being appropriated to the zinc in its porous compartment, the ratio in which—in order to satisfy all the affinities—the chromic and sulphuric acids must be used in the depolarising solution is:—

$$\underbrace{2\,H_2CrO_4}_{237} \quad \text{and} \quad \underbrace{3\,H_2SO_4}_{294}$$

If, as above, we take 25 grammes of chromic acid, the requisite proportion of monohydrated sulphuric acid is found by the proportion

237 : 294 : : 25 grammes : 31 grammes.

Now, although we are unacquainted with the precise conditions under which Dr. Tommasi's experiment was carried out, and although we do not suppose that the apparent discrepancies between the theoretical and the practical values could be wholly avoided by the simple addition of more sulphuric acid, we may suggest that when the weight of this acid, which theory shows to be requisite, is reduced nearly to one-half, it is not surprising that the performance of the battery should also fall short of what is indicated by theory.

The *initial* voltage of a chromic acid cell, it may be observed, has sometimes been given as slightly over 2 volts, even when the negative element is carbon. The mean voltage during the discharge of such a cell is very much lower than this maximum, but 1·4 volt is a low value even for this mean.

We must confess that we cannot understand why the fact that the chemical character of the negative element (cathode within the cell), and the physical condition of the substance constituting this element affect the initial and the mean E.M.F. of a couple should be put forward as an original observation. We are under the impression that this fact was familiar to electro-chemists more than a quarter of a century ago, and that Mr. Alfred Smee, amongst others, strongly insisted upon it.

The fact that the quantity of energy which is indicated by the difference of the thermal values corresponding to any given electro-chemical equation is seldom wholly exhibited in the circuit is, we believe, fully susceptible of explanation, and is, indeed, tolerably well understood by some electro-chemists in this country. This statement applies to the next example given by Dr. Tommasi, whose paper we have now under review, and whose views we have now to put forward. Any explanation not suggested in his paper must be deferred to a future occasion.

A magnesium-platinum couple in dilute sulphuric acid should, says Dr. Tommasi, have an E.M.F. sufficient to decompose water, since the heat of combination of this compound is only 69 calories, and, according to thermal data, that resulting from the action of dilute sulphuric acid upon the metal magnesium is 112·8 calories. The couple in question, however, is incapable of decomposing water; its E.M.F., therefore, cannot be higher than $\frac{69 \text{ calories}}{46} = 1{\cdot}5$ volt. The electro-chemist might be inclined to point out, in answer to this, that the couple is ill-adapted for purposes of accurate experiment, that the magnesium is rapidly acted upon, and becomes coated with bubbles of hydrogen when immersed in the acid, and that the couple, therefore, is one of hydrogen-platinum rather than magnesium-platinum. But this objection is by no means conclusive, for Dr. Tommasi points out that when a negative element of carbon is substituted for that of platinum, the couple becomes capable of decomposing water. This result cannot be ascribed to the substitution for platinum of a more electro-negative body, for carbon appears to be electro-positive to platinum in dilute sulphuric acid. The real explanation, we think, will be traced to the fact that the surface of the carbon element was enormously greater than that of the platinum plate, and that polarisation by hydrogen was incomparably less rapid, and also less complete, in the case of the carbon. We certainly cannot admit the contention that the magnesium-platinum couple is an

* "To the plate of the decomposing cell which corresponds to the zinc rod (in an ordinary battery cell) Daniell gave the name of *zincode*, which is synonymous with the *anode* of Faraday and the positive pole (or electrode) of other writers. To the plate which corresponds to the platinum or conducting metal, Daniell gave the name of *platinode*, which is synonymous with Faraday's term of *cathode*, and with the negative pole of other writers."—W. A. Miller, "Chemical Physics."

"Faraday called the metal surface at which the positive current entered the fluid the *anode* and the other surface the *cathode*."—Fleeming Jenkin, "Electricity and Magnetism," p. 67. See also Faraday's "Exp. Researches," 665, Vol. i., p. 197.

exception to the law of equivalence between the calories transmissible in the circuit and the E.M.F. of a voltaic couple.

The experiments above mentioned, together with those now to be referred to, are considered by M. Tommasi sufficient to entirely disprove Berthelot's law of maximum work, and also its reciprocal, or Sprague's law of minimum work. These two principles may be briefly expressed as follows:—

Every chemical change which takes place without the intervention of external energy tends to the production of the substance or substances which evolve the greatest quantity of heat; and

In electrolysis, those substances are set free at the electrodes which absorb, in becoming free, the least intrinsic energy, or lowest voltance.

I. When a mixed solution of nitrate of silver and nitrate of copper is electrolysed, the former metal only is deposited, until rather more than 30 molecules of the (dyad) Cu $(NO_3)_2$ are in solution for every two molecules of the (monad) Ag NO_3. By increasing the proportion of nitrate of copper, a point is reached at which the deposit contains one atom of Cu to two atoms of Ag. And, when the solution contains 87 molecules of the copper salt to two of the silver salt, one atom of Cu is deposited for each atom of Ag.

It is urged that, according to the law of Sprague, no copper should be deposited until all the silver has been removed from solution.

II. When a solution of potassic chlorate is electrolysed, the salt is converted into perchlorate, and hydrogen is evolved. But, according to thermal data, we should expect the chlorate to be reduced to chloride, and oxygen to be liberated, since

$K Cl O_3 + 3 H_2$ becoming $K Cl + 3 H_2 O$ evolves 224·6 calories.

Whilst $K Cl O_3 + O$ becoming $K Cl O_4$ evolves only 17·6 calories.

III. When a solution of binoxide of hydrogen ($H_2 O_2$) is acidulated with sulphuric acid and electrolysed, hydrogen is evolved at the negative pole; but the binoxide of hydrogen is not reduced. It has to be explained why the current should effect the decomposition of water, absorbing 69 calories, rather than that of the binoxide of hydrogen, which *evolves* 21·4 calories in becoming decomposed.

IV. In a couple consisting of a plate of amalgamated zinc in dilute sulphuric acid, contained in a porous pot, and of a plate of platinum immersed in a solution of binoxide of hydrogen to which is added a drop of sulphate of copper solution, copper is deposited on the platinum as soon as the circuit is closed. The singular fact is here to be noted that the current decomposes the (exothermic) sulphate of copper in preference to the (endothermic) binoxide of hydrogen.

On the grounds of the above experiments, Dr. Tommasi considers that the following laws may be formulated:—

1. When a body is subjected to two chemical actions, the one that will evolve the greater quantity of heat will always occur in preference, provided always that it can be initiated.

2. Of two chemical reactions, the one requiring the less quantity of heat or energy to initiate it will always preferably take place, even if it be attended with a less evolution of heat than the other reaction.

Finally, the writer of the paper states that, from what has been set forth, it follows that the principle of maximum work is entirely disproved, and it is, therefore, to be desired that it should be replaced by a new thermo-chemical principle more in accord with experience.

This new principle, which it is now proposed to term the *principle of least work*, may be formulated as follows:—

The chemical reaction which requires the least quantity of energy to initiate it will always be preferably produced, whatever may be the quantity of heat which this reaction, once commenced, may evolve or absorb.

Brussels Exhibition.—To-day there is to be a Press visit to the Exhibition of L'Electricité à la Maison, which has been arranged at Brussels by the Société Belge d'Electriciens. To-morrow, Friday, the formal opening ceremony will be performed by Prince Albert of Belgique.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1899.

Compiled expressly for this journal by **W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham,** *to whom all inquiries should be addressed.*

10,183. "A removable combination magnet and coil for electric generators and motors." C. H. CUTTING and G. H CUTTING. Dated May 15th.

10,205. "Liquid feed devices for electrolytic and kindred apparatus." R. GIROUARD. Dated May 15th. (*Complete.*)

10,215. "Improvements in electrolytic apparatus." M. HAAS. Dated May 15th. (*Complete.*)

10,219. "Improvements in or relating to the regulation of electric motors." M. T. A. KUBIERSCHKY. Dated May 15th.

10,228. "Improvements in or relating to electric controllers." A. J. BOULT. (T. von Zweigbergk, United States.) Dated May 15th.

10,238. "Improvements in coin-operated mechanism specially applicable for electric and other meters." E. DU BOIS and THE MUTUAL ELECTRIC TRUST, LTD. Dated May 15th.

10,241. "Improvements in electrical incandescence lamps with osmium filaments." O. IMRAY. (Oesterreichische Gasglühlicht and Electricitäts-Gesellschaft, Austria-Hungary.) Dated May 15th.

10,243. "Improvements relating to electrical fuse-holders." T. D. DUNDAS. Dated May 15th.

10,244. "Improvements in thermopiles." C. J. PEPPER. Dated May 15th.

10,246. "Improvement in portable telephones." L. M. ERICSSON. Dated May 15th.

10,301. "Improvements in or relating to overhead systems for electrical transmission of energy." W. ROUTLEDGE. Dated May 16th.

10,303. "An improved system or arrangement of apparatus designed for the production of electrical pressure or intensity." G. E. ADAMS Dated May 16th.

10,317. "Improved electroplating process and apparatus therefor." E. L. DESSOLLE. Dated May 16th. (*Complete.*)

10,320. "Improvements in electrodes and electrode connections in liquid feed devices for electrolytic apparatus, and in the construction of enclosing vessels for electrolytic and kindred apparatus." H. CARMICHAEL Dated May 16th. (*Complete.*)

10,336. "Improvements in controllers for electric motors." R. BELFIELD. (H. P. Davis, G. Wright, and A. J. Wurts, United States.) Dated May 16th.

10,340. "Improvements in electric meters." H. O. SWOBODA. Dated May 16th. (*Complete.*)

10,357. "An improved electric alarm clock for awakening sleepers." A. H. ARNOLD. Dated May 17th.

10,374. "Improvements in and relating to the junction boxes and other similar joints of pipes used in connection with the conducting wires of electric lighting." S. FIELDEN. Dated May 17th.

10,393. "Improvements in or relating to electro-mechanical impulse devices." H. CAMPICHE. Dated May 17th.

10,403. "A new or improved electric switch." J. J. GOODBURY. Dated May 17th.

10,406. "Improvements in wireless telegraphy." L. B. MILLER. Dated May 17th.

10,413. "An improvement in dynamo machines." C. DE KANDO. Dated May 17th. (*Complete.*)

10,416. "Improvements in incandescent electric lamps." W. MENGARINI. Dated May 17th.

10,442. "Improvements in or connected with alternating current electric arc lamps." W. J. DAVY. Dated May 17th.

10,476. "Improvements in the mountings and reflectors of electric lamps." J. HOUBOIS. Dated May 18th. (*Complete.*)

10,489. "Improved mounting or holder for reflectors of incandescent electric lamps." C. WOLFFHARDT. Dated May 18th.

10,527. "Improvements in coin-freed electrical apparatus." W. L. WISE. (F. G. Lochmann & Cie., Germany.) Dated May 18th.

10,535. "Improvements in arc lamps." H. S. DODD and R I. BAGNALL, jun. Dated May 18th.

10,536. "Improvements in and relating to electrical contact devices for explosion engines fired by electricity." J. G. ACCLES. Dated May 18th.

10,538. "Improvements in or relating to electric switch and signalling devices for railroads." O. PACINI. Dated May 18th.

10,561. "Improvements in electrical igniters for gas lamps." R J. URQUHART. (The firm of Eckel & Glinicke, Germany.) Dated May 19th.

10,590. "Improvements in the combination of electric motors with centrifugal fans or pumps." S. C. DAVIDSON and L. J STEELE. Dated May 19th.

10,596. "Electrical apparatus by means of which a prize is automatically delivered when a target is hit." J. DÖMJEN and C. SCHRÖTER. Dated May 19th. (*Complete.*)

10,606. "Improvements in thermostatic regulators." A. R. Shattuck. Dated May 19th. (*Complete.*)

10,608. "Improvements in the manufacture of conduits for electrical conductors and other purposes, and in apparatus therefor." H. S. Morrison. Dated May 19th.

10,647. "Improvements in electrical switches." A. W. Cramp. Dated May 20th.

10,670. "Improvements in apparatus for use on railway trains fitted with continuous brakes for enabling passengers to signal to drivers and guards." T. Vaughan. Dated May 20th.

10,682. "Improvements in telephones." J. D. F. Andrews. Dated May 20th.

ELECTRICAL PATENTS OF 1885 EXPIRING IN JUNE, 1899.

We are informed by W. P. Thompson & Co., that about 90 applications for electrical patents were filed in June, 1885. Of these some were never completed, and of those that were only one has been maintained to run its full term, viz, 14 years, and being of considerable interest, we give a short abstract of it below:—

6,994. "Improvements in smelting ores by an electric current and in furnaces or apparatus therefor." W. P. Thompson. (E. H. Cowles and A. H. Cowles, United States.) Dated June 9th, 1885. Relates to electric furnaces for smelting ores. The heat required for the decomposition is generated by electric resistance. One form of furnace consists of a retort of non-conducting material partially filled with a mixture of ore, *e.g.*, zinc ore, and pieces of gas carbon; one end of the retort is closed by a plate of carbon and the other by a graphite crucible. The current passes from the carbon to the crucible through the mass, which becomes highly heated, and the zinc distils over into the crucible through an opening left for the purpose. Several other forms of furnace are described suitable for non-volatile metals, in which the floors are covered with powdered charcoal, the ore and carbon forming a layer between the carbon plates, the whole being covered with charcoal; the reduced metal either runs down to a tap hole or remains mixed with the charcoal. The charcoal being a very bad conductor preserves the walls of the furnace, or other equivalent material may be employed. 3 claims.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free, 2d. (in stamps).*

1897.

21,180. "Improvements in dynamo-electric machinery." J. S. Lewis and F. J. Howitt. Dated September 15th, 1897. In a machine provided with "Sayers" coils for reversing the current in the main armature coils at the moment of commutation, the field magnet is furnished with poles the annular breadth of which is such that the distance between the forward horn or tip of one pole and the back horn of the next pole is approximately equal to the span of a "Sayers" coil. One form consists of two Sayers' coils in connection with a main armature coil and a pair of commutator sectors and the field poles. To allow the angular width of the pole pieces to be adjusted, they may each be formed in two parts, provided with slots, through which pass the securing bolts. Removable or adjustable pole tips may also be provided. Each of the poles may be hollowed out near the tip so as to reduce the difference between the magnetic fluxes when the dynamo is running at different loads. 3 claims.

21,437. "An improved method of raising and lowering electric light pendants." R. W. Fraham. Dated September 18th, 1897. *Supporting Lamps*—A swivel joint, applicable between a pendant and a ceiling plate, consists of two hemispheres of metal, china, ebonite, or other material, provided with overlapping nozzles, and connected by a bolt. A pendant thus supported may be turned up and hooked to a low ceiling, as in a shop window. 1 claim.

22,236. "Improvements in porous diaphragms for electrolytic apparatus." J. D. Dabling and C. L. Harrison. Dated September 28th, 1897. For use when electrolysing a fused mass, such as a hydroxide or halcid salt of an alkaline metal, or an alkaline earth metal, or a nitrate or sulphate of such metal, a porous diaphragm is employed constructed as follows:—Two concentric perforated sheet metal cylinders, having solid bases, are provided, and the annular space is filled with a vitrified oxide, such as magnesia, or oxides, crushed or broken up to a proper degree of fineness. A layer of cement is put over the vitrified particles. The diaphragm may be of other forms. 3 claims.

22,339. "Improved electric motor-car switch." O. C. Immisch. Dated September 29th, 1897. Relates to electrically propelled vehicles and consists of a switch for putting auxiliary cells in or out of action, or opposing them to the main current, for regulating the speed and power; also of means for preventing injurious sparking in the switch when the circuits are broken or charged. In one position the switch arms are disposed so that the main battery and auxiliary cells are opposed in the circuit of the motor. In another position the auxiliary cells are cut out and in a third position they are shown as assisting the main battery. The invention is also illustrated as applied to a motor with two commutators, and as applied with a main battery in two parts. Either the parts of the battery or the motor commutators may be placed in series or in parellel. In order to prevent injurious sparking, the switch arm is furnished with an additional contact, by which, at the moment of making or breaking contact the circuit of an electro-magnet is closed. By this means the main circuit is momentarily broken by the rising of a core from a cup. 4 claims.

22,627. "Improvements in alternating arc lamps." B. M. Drake and J. M. Gorham. Dated October 2nd, 1897. Relates to arc lamps. To reduce the noise produced by an alternating current lamp, the core of the regulating solenoid is connected with the mechanism by a metal spring, which may be spiral or laminated, and which has a vibration rate differing from the rate of alternation of the current. 1 claim.

22,697. "Improvements in cut-outs for electric lighting and other purposes. T. Taylor. Dated October 6th, 1897. *Electric Cut-outs.*—The object is to increase the length of fuse wire and to minimise the risk of short-circuiting. The base is formed with a boss having, in double-pole cut-outs, four grooves for the reception of the terminal plates. These are bevelled, and slide in under-cuts in the boss. The leads are led up through holes in the base, and are secured by screws. To prevent lateral movements of the terminal plates, the screws which secure the fuses pass into holes in the base. The boss is formed with hollow or scalloped faces, so that the wires only touch at the peaks. In single-pole cut-outs the terminals are not required, and the fuse wire is led round the boss, which may be variously modified in shape to give air space. 4 claims.

23,192. "A dynamo-electric machine and motor." A. H. Finlay. Dated October 9th, 1897. Relates to dynamos and motors of the "unipolar" type. An iron cylinder carried by a shaft rotates within a stationary hollow iron cylinder. One part, preferably the cylinder, carries an exciting coil. Insulated copper conductors extend through slots or holes in adjacent parts of the iron parts. Each armature conductor terminates in segments of two commutators, and each conductor in two brushes which are placed so as to connect the inner end of one armature conductor through the conductor to the outer end of the next armature conductor but one. The intervening armature conductor is out of circuit, the brushes being narrower than the segments of the commutators. The brushes slide in fixed boxes, or are replaced by curved pieces of metal or carbon, supported so that they can turn about the conductors. All the conductors are thus preferably connected in two parallel series. Each slot or hole in the armature preferably contains two or more conductors connected to different commutator segments, in order that the total current flowing within the slot may be uniform. The iron parts may be laminated, in order that the machine may be used as an alternating current motor; it is supplied through a transformer, which may consist of coils replacing the exciting coil in the motor itself. In modifications, the iron parts may extend symmetrically on both sides of the conductors and be provided with two exciting coils. The commutators may be of disc form. The armature conductors may be connected to one or more pairs of collecting rings, in place of the divided commutators; such a motor with all the conductors connected in parallel, and mercury contacts, may be used in electricity meter. 8 claims.

23,304. "Improvements in magnetic circuit arrangements for dynamo-electric machines and other purposes." R. Wood. Dated October 11th, 1897. Relates to improvements in magnetic circuits for dynamo-electric machines, for magnetically relieving pressures, and for counteracting centrifugal force; and consists in employing means for decreasing the reluctance of an air-gap in a magnetic circuit, and for varying the magnitude and direction of the magnetic pull across the gap. One part of the circuit is necessarily movable with respect to the other part, and the device adopted consists in forming the opposing surfaces with a series of ridges and grooves fitting one within the other. Applied to a double horse-shoe drum dynamo, the internal faces of the magnets and of the laminated armature which they surround are provided with corresponding ridges and grooves. The armature may be decentralised radially or longitudinally to vary the magnetic pull as desired. When applied to a rapidly rotating disc, either of iron or steel, or of aluminium or other metal, plated or fitted with iron on its ridges and grooves, the ridges and grooves are made on the top and bottom surfaces of the disc, and electro-magnetic rings having corresponding ridges and grooves are placed above and below. The outside ridges on the magnet are nearer to the insides of the disc ridges than the insides of the magnet ridges are to the outsides of the disc ridges. In this case also the disc can be decentralised radially or axially, and it may be used as an armature. 1 claim.

24,131. "Improvements in and relating to electric controllers." The British Thomson-Houston Company, Limited. (H. G. Reist, United States.) Dated October 19th, 1897. Relates to controllers for alternating current motors, consisting of combined reversing and resistance switches operated by one handle. A resistance switch is fitted within a casing and comprises contacts carried on arms mounted on a shaft, and suitable sets of fixed contacts. The reversing switch is mounted in a casing or vessel containing oil. Its spindle is fitted with a toothed wheel gearing with a pinion fitted with a handle. A link connects the wheel with a sector fitted with teeth engaging with a segment carried by a shaft. With this arrangement a movement of the reversing switch from the "off" position in either direction moves the resistance switch in the same direction; also the first movement of the handle produces very little effect on the regulating switch, but this effect rapidly increases as the handle is moved further. A toothed segment is provided for holding the switch in position, and a cam for the switch. 16 claims.